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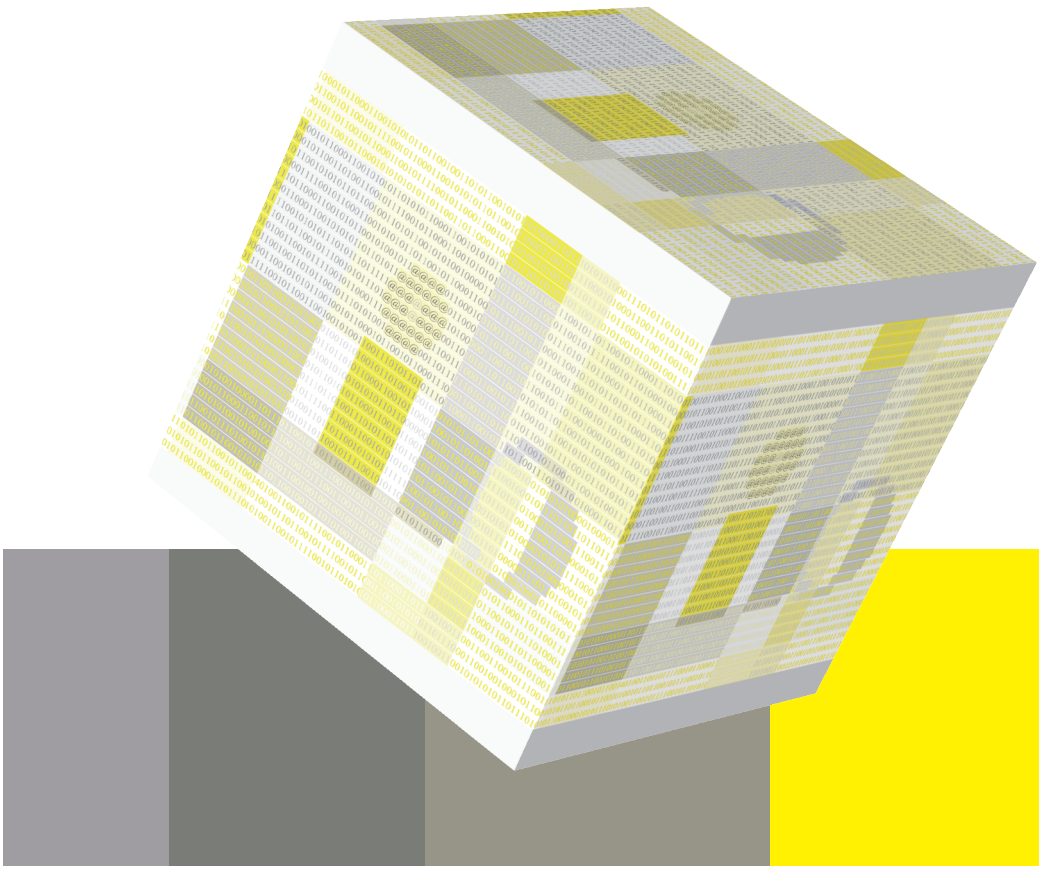

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教育資料與圖書館學 JOURNAL OF EDUCATIONAL MEDIA & LIBRARY SCIENCES Vol. 62, No.2, 2025

教育資料與圖書館學，始於1970年3月創刊之**教育資料科學月刊**，其間於1980年9月更名為**教育資料科學**，並改以季刊發行。自1982年9月起易今名。另自2016年11月起，改以一年出版三期（3月、7月、11月）。現由淡江大學出版中心出版，淡江大學資訊與圖書館學系和覺生紀念圖書館合作策劃編輯。本刊為國際學術期刊，2008年獲國科會學術期刊評比為第一級，2015年獲科技部人文社會科學研究中心評定為教育學門專業類一級期刊。並廣為海內外知名資料庫所收錄(如下英文所列)。

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L (Librarianship); **I** (Information Technology); **B** (Bibliophile and the Book trade)

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(3) published source must be acknowledged with citation.

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Editorial

The Mission and Responsibilities of Academic Journal Publishers

In 2018, the internationally renowned Society for Scholarly Publishing (SSP) published an updated version of "Focusing on Value: 102 Things Journal Publishers Do" proposed by Kent Anderson, former president of the Society. Since the publication of the initial edition, it has undergone several revisions.[1] The initiative was first published in 2012 on The Scholarly Kitchen's blog, which was run by the SSP, to solicit widespread opinions on "A Proposed List — 60 Things Journal Publishers Do", and was finally expanded to 102 Things in the most recent update in 2018. This list has been used in the core structure of academic publishing-related organizations and training for new editors.

Kent Anderson attempted to categorize the stakeholders related to these 102 items into 11 groups: authors, editors and reviewers, funders, institutions, librarians, publishers, readers, researchers, service providers, and academic communities. Among these, 37 items are directly relevant to journal editorship, with their serial numbers and items listed below:

4. Make money and remain a constant in the system of scholarly output
5. Plan and create strategies for the future
6. Establish, cultivate, and maintain a good reputation
9. Solicitation of materials
10. Rejection of submissions
11. Cascading of rejected manuscripts from one journal to another
12. Acceptance of submissions
13. Tracking of submissions throughout
14. Tracking changes in the authorship environment
15. Plagiarism detection
17. Recruitment and retention of editors and reviewers
23. Training of editors
24. Editorial board meetings
25. Editor meetings
27. Ethics investigations
28. Staff training
30. Implement and enforce editorial policies and procedures)
40. Design print and various online versions

[1] Kent Anderson, "Focusing on Value — 102 Things Journal Publishers Do (2018 Update)," Scholarly Kitchen, February 6, 2018, accessed July 14, 2025, https://scholarlykitchen.sspnet.org/2018/02/06/focusing-value-102-things-journal-publishers-2018-update/.

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43. Publisher migrations
64. Comment and community moderation
66. Anti-piracy efforts
68. Supplement proposals
70. Analytics and abuse monitoring
73. Managing and protecting editorial records
75. Basic management functions
76. Construct annual budgets and financial projections
77. Extended management functions
79. Organizational education
80. Board interactions
85. Interact with agents for institutional and individual sales
89. Maintain facilities
93. Conduct market research
95. Conduct new customer marketing
98. Creative, A/B testing, renewal monitoring
100. Pay for and comply with terms of publisher insurance policies
101. Work together to solve more general access and fairness issues
102. Benchmark and compare notes

However, Anderson's 102 Things, as well as the journal editor's most important 37 items, fail to cover the Point 3 "Publishing Schedule", Point 4 "Archiving", and Point 15 "Advertising Publications" in the COPE's *Principles of Transparency and Best Practice in Scholarly Publishing*.[2] In this regard, if we return to the item-by-item comparison of 102 Things, Point 3 of the COPE's principles, "Publishing Schedule", corresponds to Item 49 of 102 Things, "Rapid Publication Practices", and the most interested parties in this item are the authors, researchers, and readers; Point 4 "Archiving" in the COPE's principles corresponds to Item 60 "Custody and Archives" of 102 Things, where the most interested parties are researchers, authors, readers, librarians, and publishers; Point 15 of the COPE's principles, "Advertising", corresponds to 102 Things' Item 82, "Selling Advertisements, Reprints, and Monographs," and the most interested parties in this item are researchers, authors, and publishers.

As a publisher of an academic journal, how much time and effort do we have to devote to these two important historical documents? And under the limited environmental conditions, how much ability is enough to target one's own weaknesses and strive for improvements? Under the ideal goal of internationalization of journals, in addition to actively participating in the

[2] COPE et al., "Principles of Transparency and Best Practice in Scholarly Publishing — English," Committee on Publication Ethics, September 15, 2022, accessed July 14, 2025, https://doi.org/10.24318/cope.2019.1.12.

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activities of international organization members, perhaps a sustainable solution still depends on the best practices and applications of substantive national organization (or learned society and scholarly commuity) that provide step-by-step assistance and supervision to their journal members.

Back to the report of this volume issue (Vol. 62, No. 2). It has been the 55th anniversary of the founding of *JoEMLS*, and the senior managing editor Sz-Shi Kao has dedicated more than 50 years of his golden age to the journal, and has just officially retired from this issue. Over the years, Mr. Kao has devoted himself to the editor's proofreading and has made great contributions to the quality improvement and achievements of this journal, and the editorial team of *JoEMLS* is deeply moved and deeply grateful.

The rejection rate of this issue is 50%, and a total of eight manuscripts have been received, and four of them have been accepted and published. We are so grateful for everyone's contributions to this journal. It wouldn't have been the same without your support. Four articles in this issue, they are: "Research Trends on Digital Health Literacy of Young Adults: A Bibliometric Analysis" by Thi Kim Thoa Ninh et al.; "Factors Influencing Secondary School Teachers' Adoption of Online Professional Development in Taiwan: An Extension of the Technology Acceptance Model" by Chiung-Sui Chang; "Integrating Cultural Literacy and PBL Strategies into 3D Design Courses: A Case Study of University Social Responsibility Practices" by Shih-Chieh Hung; and "Exploring the Development of User Experience Research: A Main Path Analysis of Research Citation Networks" Shu-Yi Chen and three other authors. The journal has always upheld its responsibility and mission in publishing.

Jeong-Yeou Chiu
JoEMLS Editor-in-Chief
Chang-Huei Lin
JoEMLS Editor

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編者言

學術期刊出版者的職責願景

國際知名的學術出版學會（Society for Scholarly Publishing，簡稱SSP）在2018年曾發表該會前主席Kent Anderson所倡議的「聚焦價值：學術出版者102工作要項」（Focusing on Value: 102 Things Journal Publishers Do）新增版；從刊出初始版本之後，已歷經多次增修。[1] 此倡議首見於2012年該SSP官方經營的*The Scholarly Kitchen*部落格平台，即針對學術出版社在出版流程中所需留意的60件事（*A Proposed List — 60 Things Journal Publishers Do*）廣徵意見，終至2018年的最近更新版本中已擴增至102要項（簡稱*102 Things*）。此份清單已被運用於各學術出版相關組織與新進編輯者培訓的核心架構內容。

Kent Anderson嘗試將這102要項工作的相關利益者，分成作者（authors）、編輯和審稿者（editors and reviewers）、資助者（funders）、機構（institutions）、圖書館員（librarians）、出版社（publishers）、讀者（readers）、研究人員（researchers）、服務商（service providers）以及學術社群（society）等11種，其中對於期刊編輯有直接相關的項目就高達37項，其序號及項目如下所列：

4. 創收並在學術產出系統中保持穩定（Make money and remain a constant in the system of scholarly output）
5. 規劃和制定未來策略（Plan and create strategies for the future）
6. 建立、培養與保持良好學術名聲（Establish, cultivate, and maintain a good reputation）
9. 稿件與材料徵集（Solicitation of materials）
10. 稿件之退稿（Rejection of submissions）
11. 退稿之轉引介（Cascading of rejected manuscripts from one journal to another）
12. 稿件之接受（Acceptance of submissions）
13. 全程追蹤稿件進度（Tracking of submissions throughout）
14. 追蹤作者群之變化（Tracking changes in the authorship environment）
15. 抄襲檢測（Plagiarism detection）
17. 編輯與審稿者之聘請與留用（Recruitment and retention of editors and reviewers）
23. 編輯培訓（Training of editors）
24. 編委會會議（Editorial board meetings）
25. 編輯會議（Editor meetings）
27. 倫理審查（Ethics investigations）

[1] Kent Anderson, “Focusing on Value — 102 Things Journal Publishers Do (2018 Update),” Scholarly Kitchen, February 6, 2018, accessed July 14, 2025, https://scholarlykitchen.sspnet.org/2018/02/06/focusing-value-102-things-journal-publishers-2018-update/.

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28. 編輯成員訓練（Staff training）
30. 貫徹編輯政策與執行步驟（Implement and enforce editorial policies and procedures）
40. 設計印刷版本與各種線上版本（Design print and various online versions）
43. 出版社轉移（Publisher migrations）
64. 評論與社群審核（Comment and community moderation）
66. 防治非法複製之措施（Anti-piracy efforts）
68. 增刊建議（Supplement proposals）
70. 數據分析與濫用監測（Analytics and abuse monitoring）
73. 管理與保護編輯記錄（Managing and protecting editorial records）
75. 基本管理功能（Basic management functions）
76. 制定年度預算和財務預測（Construct annual budgets and financial projections）
77. 擴展管理功能（Extended management functions）
79. 機構組織之教育（Organizational education）
80. 編委會之互動（Board interactions）
85. 與機構和個人銷售的代理商進行互動（Interact with agents for institutional and individual sales）
89. 維護有關設施與特色（Maintain facilities）
93. 進行市場研究（Conduct market research）
95. 開發新客戶（Conduct new customer marketing）
98. 創造、A/B測試、續約監測（Creative, A/B testing, renewal monitoring）
100. 支付並遵守出版社保險政策的條款（Pay for and comply with terms of publisher insurance policies）
101. 共同解決更普及之取用與公平性問題（Work together to solve more general access and fairness issues）
102. 標竿學習和與其他出版社比較（Benchmark and compare notes）

然而，上述Anderson所制定的*102 Things*之中，與期刊編輯業務最相關的37項工作範疇，卻未能涵蓋到COPE的「學術出版透明度最佳實踐原則」（*Principles of Transparency and Best Practice in Scholarly Publishing*，以下簡稱最佳實踐原則）中的第3點「出版時程」、第4點「典藏」以及第15點「廣告刊登」等議題。[2] 對此，若回歸到*102 Things*逐項比對，有關於「最佳實踐原則」中的第3點「出版時程」則可對應到*102 Things*第49項「快速出版實踐」，而此項最有利益關係者則是作者、研究者及讀者；「最佳實踐原則」中的第4點「典藏」則可對

[2] COPE et al., "Principles of Transparency and Best Practice in Scholarly Publishing — English," Committee on Publication Ethics, September 15, 2022, accessed July 14, 2025, https://doi.org/10.24318/cope.2019.1.12.

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應到*102 Things*第60項「託管和典藏」，而此項最有利益關係者則又是研究者、作者、讀者、圖書館員以及出版社；「最佳實踐原則」中的第15點「廣告刊登」則可對應到*102 Things*第82項「銷售廣告、再版和單行本」，而此項最有利益關係者則是研究者、作者以及出版社。

身為學術期刊出版者，在上述兩項重要歷史文獻的指引下，究竟有多少時間及心力可以專注於此？並且在有限的環境條件下，又有多少能力足以針對自身弱點，而力謀改善之道？在期刊國際化的理想目標下，除了積極參與國際組織成員活動之外，或許永續的解決途徑仍須仰賴：更有組織與架構性的全國指導單位（或專業學會社群機構）的統籌擘畫，對其期刊會員就近給予逐步協助與督促輔導，如此這般，才可能有實質且貼切所處自身環境的最佳實踐及應用。

且將話題轉回本卷期（62卷2期）之報告。本刊創刊已屆55週年，資深前輩暨編輯高祺熹老師佐理本刊，奉獻了50多年的黃金歲月，甫於此刊期正式退休。高老師向來為人謙恭和善、提攜後進，多年來專注於編輯校對之重責，對本刊品質提升與各項成就有莫大貢獻，本刊編輯團隊深受感動並深表感激。

本卷期退稿率為50%，總計收到投稿稿件八篇，評閱通過刊登其中四篇，它們分別為：Thi Kim Thoa Ninh等四位作者的「Research Trends on Digital Health Literacy of Young Adults: A Bibliometric Analysis」、Chiung-Sui Chang的「Factors Influencing Secondary School Teachers' Adoption of Online Professional Development in Taiwan: An Extension of the Technology Acceptance Model」、洪士傑的「文化素養與PBL策略融入3D設計課程中的USR實踐：以某大學社會責任實踐計畫為例」，以及陳書儀等三位作者所撰寫的「探索使用者經驗研究發展趨勢：學術引文網路的主路徑分析」。感謝所有的投稿者與評閱者，本刊始終銘記期刊出版的責任與使命。

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Research Article

Research Trends on Digital Health Literacy of Young Adults: A Bibliometric Analysis

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Abstract

Establishing solid health foundations in the early stages of life is crucial for enabling all individuals to benefit from the changes in digital health. Healthcare services need to be adapted to meet the diverse needs of young people, considering their varying levels of digital literacy. This research sought to conduct a bibliometric analysis of research articles addressing digital health literacy among young adults. The utilization of VOSviewer, Carrot2, and CiteSpace tools enabled the examination of 380 articles from the Scopus database on digital health literacy of young adults to identify emerging research subjects, collaboration patterns, and changes in research focus over time. The analysis indicates a significant growth in publications addressing youth digital health literacy. Emerging research subjects include educating people on digital health information, managing public health crises, exploring digital health behaviors and attitudes, and discussing telehealth technology. The discussed subjects point to a heightened interest in educational frameworks, crisis management approaches, behavioral insights, and technological progress in digital health literacy, potentially shaping the direction of future research in this field. The analysis also reveals trends in collaboration among countries and key journals. The study results may be used to design educational and training initiatives focusing on digital health literacy and enhancing health management approaches during digitalization and global crises. The study is constrained by its use of only the Scopus database, which does not encompass all pertinent databases and research areas. Future bibliometric studies might expand to consider more databases for a comprehensive analysis.

Keywords: *Digital health literacy, Bibliometric analysis, Health information literacy, Electronic health literacy, Young adult*

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Introduction

The management of healthcare has become a key priority nationally, regionally, and globally. At the global level, the World Health Organization's (2019) launch of The Global Action Plan for Healthy Lives and Well-being for All in 2019 involved the coordination of 13 multilateral health, development, and humanitarian organizations. The aim is to assist nations in speeding up advancements toward health-related Sustainable Development Goals by making commitments to enhance cooperation among agencies, working together to support national plans and strategies better. At the regional level, the European Commission's (2012) report indicates a persistent growth in public health expenditure across the 27 European Union member states, climbing from 5.9% of GDP in 1990 to 7.2% in 2011, with expectations of a rise to 8.5% by 2060 due to the aging populace. Simultaneously, there is a projected sharp drop in the labor force from 61% to 30% of the overall population by 2060. There has been an escalation in financial burdens on public budgets, a consistent drop in the number of healthcare professionals, a rise in chronic ailments among citizens, and an increase in the public's expectations for superior social services and care. In response to these challenges, digital health solutions are increasingly being leveraged to enhance healthcare delivery, improve access to health information, and support health literacy efforts. The health market is rapidly expanding while being supported by digital technology. The European Commission's eHealth Action Plan 2012-2020 is geared towards achieving four specific aims: increasing interoperability in eHealth services, backing research, innovation, and competition in eHealth, simplifying the adoption and deployment of eHealth, and advocating for policy dialogue and global cooperation on eHealth (European Commission, 2012). At the national level, healthcare is a top concern in places such as Vietnam, a developing nation. As part of its healthcare strategy, Vietnam has also embraced digital health initiatives, recognizing the role of technology in improving health literacy and healthcare accessibility. The issuance of the "Vietnam Health Program" included a goal to heighten awareness and influence the behavior of individuals and communities in protecting health (Prime Minister of Vietnam, 2018). The Government of Vietnam has also given the green light to health initiatives for different segments of the population, including the "Elderly Health Care Program until 2030" (Prime Minister of Vietnam, 2020) and the "School Health Program for the period 2021-2025" (Prime Minister of Vietnam, 2021) as endorsed by the Prime Minister in 2020 and 2021 respectively. Additionally, efforts in digital transformation, such as the introduction of electronic health records by the Ministry of Health, further emphasize the increasing importance of digital health literacy (DHL) in national

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healthcare policies. These developments illustrate how nations at different levels of development are addressing healthcare challenges and leveraging digital technologies to enhance health management and health literacy, which form the foundation of this study. This shift is part of a broader digital transformation in healthcare, giving rise to the concept of 'digital health,' defined as "the field of knowledge and practice associated with the development and use of digital technologies to improve health" (World Health Organization, 2021).

Digital health technologies' utility is dependent on the integration of digital competencies and DHL (Kickbusch et al., 2021). Advocating for the development of DHL is one of the major priorities in national health policies. The drive to provide healthcare services to diverse populations, including young adults, is regarded as pivotal in establishing a healthy future and fostering sustainable development in the community and society. Young individuals can enhance their ability to make wise choices and enhance their actions by possessing DHL, ultimately aiding in the prevention of mental anguish and the preservation of their well-being (Chen et al., 2022, 2023). Given this, there has been a notable surge in research on DHL, including bibliometric studies, reflecting an increasing recognition of the importance of investigating this area. However, despite systematic bibliographic analyses of fundamental DHL concepts, prior studies have not sufficiently explored DHL within specific communities, such as young adults. To rectify the gaps in bibliometric research concerning DHL, three objectives were established as follows:

(1) Analyze the collaboration between authors and nations in research on young adults' DHL;
(2) Identify key research subjects concerning young adults' DHL;
(3) Recognize emerging and potential research tendencies and leading journals in the realm of young adults' DHL.

Based on this, the article puts forward suggestions for future research and contributes to the advancement of digital literacy and the health of young adults in practice and theory.

Literature Review

Digital Health Literacy Concept

Digital health is a sector that has evolved from the convergence of technology and healthcare, focusing on utilizing digital technology to enhance health outcomes. World Health Organization (2021, p. 11) defines digital health as "the field of knowledge and practice associated with any aspect of adopting digital technology to improve health, from inception to operation". This definition points out the capacity of digital tools to drive transformations

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in healthcare scenarios, encompassing telehealth and health information management systems. As digital health services expand, digital literacy has become increasingly crucial in healthcare. According to the American Library Association (2011), digital literacy is "the ability to use information and communication technologies to find, evaluate, create, and communicate information, requiring both cognitive and technical skills". Possessing these competencies is key for both healthcare professionals and patients to effectively utilize digital health technologies in the healthcare setting.

While digital literacy is important, it is not the only requirement for optimal health; health literacy is also significant. Health literacy is "the cognitive and social skills which determine the motivation and ability of individuals to gain access to, understand, and use information in ways which promote and maintain good health" (Nutbeam, 1998, p. 357). The true potential of digital health is unlocked by merging health and digital functionalities. In this study, DHL is described as the capability to search for, comprehend, and evaluate health information from electronic sources or in digital environments, and then apply this information to resolve health issues (European Commission, 2014; van der Vaart & Drossaert, 2017). Making health decisions through online platforms is a key aspect of empowering individuals.

While DHL caters to individuals of all ages, young adults stand out as especially significant because of their strong dependence on digital platforms for health-related information (Norman & Skinner, 2006; Stellefson et al., 2011). However, they also face unique challenges, including exposure to misinformation and difficulties in critically assessing health content (Gaysynsky et al., 2024). These factors underscore the need for further research on DHL in this group to improve their ability to make informed health decisions.

According to the World Health Organization (2021), digital health has expanded to include eHealth. In terms of definition, the concept of DHL in this study is seen as an extension of eHealth literacy and can be used interchangeably. Perhaps the only variation is the transition from electronic to digital platforms for obtaining and managing health information. This transition reflects a broader shift in digital health, moving from static, structured repositories to more dynamic and interactive health systems. The evolution of digital health technologies is resulting in the supplementation or replacement of traditional electronic systems, such as static databases, with dynamic digital solutions that enable real-time communication, personalized interactions, and integration across various platforms. Among these are health apps for mobile devices, AI-driven healthcare systems, and telehealth services, all of which enhance the connectivity and responsiveness of the healthcare landscape (Bawden & Robinson, 2022; Norman

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& Skinner, 2006; Pagliari, 2021). The term DHL is consistently used in this study to refer to research that concentrates on interactions with digital information, including electronic information, regarding human health issues.

Bibliometric Study of Digital Health Literacy

With the digital landscape evolving rapidly, it is increasingly important for individuals to possess digital literacy to engage with health-related content online. Techniques involving citation networks and research trend analysis have been employed to investigate this particular field (Hao et al., 2024; Jabeen et al., 2023; Nwagwu, 2024; Qi et al., 2021; Tian & Chen, 2022; Wang et al., 2022; Wang & Si, 2023; Yang et al., 2022). The use of bibliometric analysis techniques in these studies helped in mapping out the scientific literature related to DHL or health literacy. These studies sourced data primarily from the Web of Science (Hao et al., 2024; Qi et al., 2021; Tian & Chen, 2022; Wang et al., 2022; Wang & Si, 2023; Yang et al., 2022) and Scopus (Jabeen et al., 2023; Nwagwu, 2024), employing software such as VOSviewer, CiteSpace, Bibliometrix and Biblioshiny for data examination. Some studies relied on a single software tool like Wang et al. (2022), Tian and Chen (2022), Qi et al. (2021), Wang and Si (2023), and Nwagwu (2024), while others integrated multiple tools such as CiteSpace and VOSviewer (Hao et al., 2024; Yang et al., 2022), or Biblioshiny and VOSviewer (Jabeen et al., 2023). The studies looked into the most significant authors, articles, and journals in the area of DHL. This approach not only establishes a unified data platform for analysis but also enables a direct comparison of research results.

Bibliometric analysis has been widely utilized to examine research trends, collaborative patterns, and emerging topics in various scientific fields (Donthu et al., 2021). By exploring citation networks alongside keyword co-occurrences, this technique provides valuable perspectives on the changing landscape of research, highlights influential publications, and charts the evolution of critical themes over time. Furthermore, bibliometric tools allow for the visualization of scholarly impact, making it possible to assess interdisciplinary contributions and global collaboration dynamics in specific research domains. In the realm of DHL, bibliometric techniques offer important perspectives on changes in research priorities, the influence of worldwide occurrences (such as the COVID-19 crisis), and the level of global cooperation in this area.

Bibliometric studies conducted by Nwagwu (2024), Hao et al. (2024), Jabeen et al. (2023), Wang and Si (2023), Qi et al. (2021), Tian and Chen (2022), Wang et al. (2022), and Yang et al. (2022) highlight the dominance of the United States and European nations in research on DHL, with substantial participation from interdisciplinary groups in healthcare, education, and information technology. The significance of combining educational and technological features in digital

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health systems is emphasized in these research studies. Additionally, an analysis of these studies suggests a transformation in research themes within DHL over time, with the emergence of new research areas such as digital health interventions and online health prevention; more recently, there has been an increased focus on mental health. Studies reveal a robust expansion and varied progress in digital health sectors. The COVID-19 pandemic has had a noticeable effect on DHL research (Jabeen et al., 2023; Wang & Si, 2023). The extent of collaboration between Eastern and Western nations on a global level remains restricted, even though many countries are actively involved. While research aims and analytical techniques vary, there is consistency in the tools and data utilized in bibliometric analysis across studies. Employing this analytical approach aids in clarifying the contributions of the studies to the digital health field and serves as a foundation for evaluating future research opportunities. These results underscore the necessity of continuing to delve into and broaden international partnerships, as well as concentrating on novel and critical research themes in the future.

Although there has been a rise in bibliometric studies concerning DHL, the majority have concentrated on the general population, neglecting specific groups like young adults (Jabeen et al., 2023; Wang & Si, 2023). Several previous bibliometric analyses have examined DHL trends (Hao et al., 2024; Qi et al., 2021; Tian & Chen, 2022; Wang et al., 2022; Yang et al., 2022), but these studies primarily focus on broad patterns across populations rather than age-specific insights. Research reviews focused on DHL emphasize the necessity for additional empirical studies involving various demographic populations to uncover contextual elements that affect DHL and to create specific interventions (Kim et al., 2022). While systematic reviews have examined eHealth literacy among college students, research on DHL in broader young adult populations remains limited (Stellefson et al., 2011). Given their distinct engagement with digital health platforms, understanding research trends in DHL among young adults is essential. There is a dearth of bibliometric investigations in this area, underscoring a vital deficiency in the body of existing research. This research seeks to bridge the existing gap by comprehensively analyzing the literature related to DHL in young adults, yielding insights that can support the development of specialized digital health programs and promote better health outcomes for this population.

Methodology

The research employed bibliometric techniques to analyze data extracted from scientific articles focusing on the DHL of young adults. Relevant scientific

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articles from the Scopus database were the primary data source for collection. The investigation was divided into three stages, as illustrated in Table 1.

Table 1 Progression Through the Various Stages of Research

Stage 1: Data collection	• Keywords and search expressions: ("health information literacy" OR "digital health literacy" OR "e-health literacy" OR "electronic health literacy" OR "eHealth literacy") AND ("young people" OR "students" OR "young adult") • Search fields: Title, abstract, keyword, then filtered the results using the same keywords as indexed by Scopus • Publication year range: From 2014 to 2024 • Language: English • Document type: Articles • Search date: June 22, 2024 • Number of articles: 380
Stage 2: Data analysis and visualization	• Microsoft Excel: Descriptive statistics of publication distribution and subject categories • VOSviewer: ✓Mapping all keywords co-occurrence; ✓Mapping co-authorship relations by countries; ✓Mapping the most prominent journals. • Carrot2: Keywords clustering • Citespace: Mapping timeline of keywords
Stage 3: Results and discussions	• Trends of themes • International cooperation and networking • Top source journals • Future research directions

The search strategy utilized a combination of terms related to Digital Health Literacy (DHL) and young adults, ensuring the study's focus on this demographic. The search was conducted across multiple fields - title, abstract, and keywords - using the following query: ("health information literacy" OR "digital health literacy" OR "e-health literacy" OR "electronic health literacy" OR "eHealth literacy") AND ("young people" OR "students" OR "young adult"). By using the conjunction (OR) for variations of DHL and (AND) for terms such as "young people", "students" or "young adults", we captured a comprehensive set of articles specifically relevant to young adult populations. The conjunction (OR) included various terms related to DHL, ensuring broad concept coverage. These terms were then connected with terms like "young people", "students" and "young adults" using the AND operator. This approach ensured that the search results included studies discussing DHL specifically in the context of young adult populations. The search was limited to articles published in English between 2014 and 2024, filtered by the same search term as keywords indexed in Scopus, resulting in a dataset of 380 articles. The search strategy focused on the keywords "young people", "students" and "young adult" with the term "students" inherently encompassing "college students". Upon further examination of the dataset, the keyword "college students" was associated with 24 relevant studies, confirming that this demographic was sufficiently captured within the broader

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term “students”. Furthermore, the term “students” appeared in 131 studies, reinforcing the significant representation of college students in the dataset.

Scopus data is downloaded and validated for consistency before being incorporated into bibliometric analysis software. VOSviewer, Carrot2, and Citespace software are put to use. VOSviewer software is utilized to generate keyword network maps, conduct keyword co-occurrence analysis to identify important keywords and their interconnections, create co-authorship network maps to visualize collaboration between countries, and map the most prominent journals. The Carrot2 tool is used for keyword-driven text clustering, which organizes articles by specific keyword themes, explores major thematic clusters, and enhances understanding of research topics and trends in the field. Citespace is a specialized tool for visualizing and analyzing scientific literature, which facilitates the mapping of trends and relationships within specific research fields. In this study, Citespace was employed to create a timeline view of keywords, offering a detailed visualization of the evolution and focal areas of the research domain over time. Together, these tools enhanced the depth and clarity of the findings by offering different perspectives on collaboration, thematic clusters, and research trends in DHL.

The analysis results synthesize and interpret findings, offering a comprehensive overview of research trends, prominent themes, international collaborations, leading journals, and potential future research directions in DHL among young adults. By executing the established research objectives and employing appropriate analytical tools, the study generates important findings on youth DHL, thereby contributing to the development and application of scientific and practical knowledge in this particular field.

Results

Through a quantitative analysis of publications on youth DHL, the study provides a comprehensive view of the changing landscape of scholarly interests in the field, highlighting research collaborations, themes, trends, and publication sources.

Publishing Trends Over the Years

This section describes the characteristics of the dataset, highlighting the quantitative development of research in the field. With regards to the number of articles, statistical results utilizing the number of samples gathered (Figure 1) reveal a notable surge in publications discussing the DHL of young adults from 2019 to 2023. There seems to be a growing concern and recognition of the significance of studying this study area.

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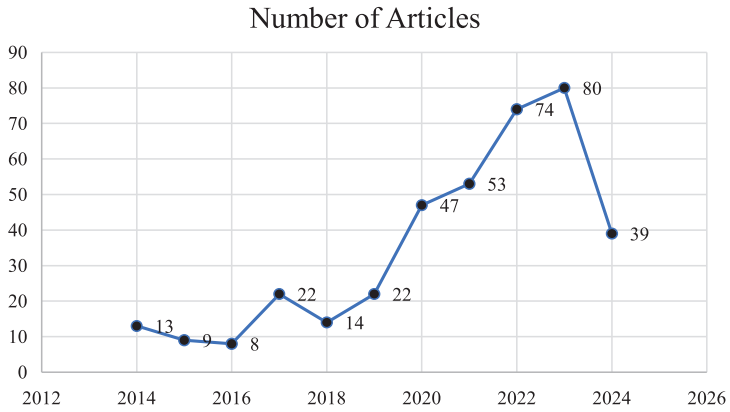
Figure 1 Statistics on Articles by Publication Year From 2014 to 2024



Trends in Research Collaboration

This section mainly focuses on Objective 1: Analyzing collaboration trends in young adults' DHL research and exploring the partnerships between authors, and countries. The study examines how individual authors and countries collaborate in researching the DHL of young adults. Research indicated that a small group of authors (n = 19) worked individually, while only eight authors collaborated on at least two publications. The data were analyzed using the full counting method to determine the co-authorship network between different countries. A circle on the map represents each nation, and the circle's size corresponds to the number of scientific publications produced by that country on the research themes. The distance between the circles is a measure of the strength of the co-authorship association between the countries. The closer the circles, the more significant the co-authorship correlation. Through the full counting method, Figure 2 showcases a data visualization of the countries that participated in the investigation on DHL among young adults. Among the 79 countries, 23 are featured in the network map with a presence of at least seven documents. The data analysis identified five clusters that engaged in collaborative research efforts, each country has a minimum of n = 7 documents.

China, Hong Kong, Japan, Pakistan, Taiwan, and Vietnam are included in Cluster 1 data (red color), indicating the involvement of multiple Asian countries, suggesting a high level of collaboration in this region. Countries like China, Japan, and Hong Kong are known for their wide-ranging research networks and collaborations with numerous nations. The inclusion of Pakistan and Vietnam suggests a growing tendency toward increased research partnerships with developing nations. Cluster 2 (green color), which includes Germany, Australia, Ghana, and Italy, illustrates a diverse range of countries from various continents,

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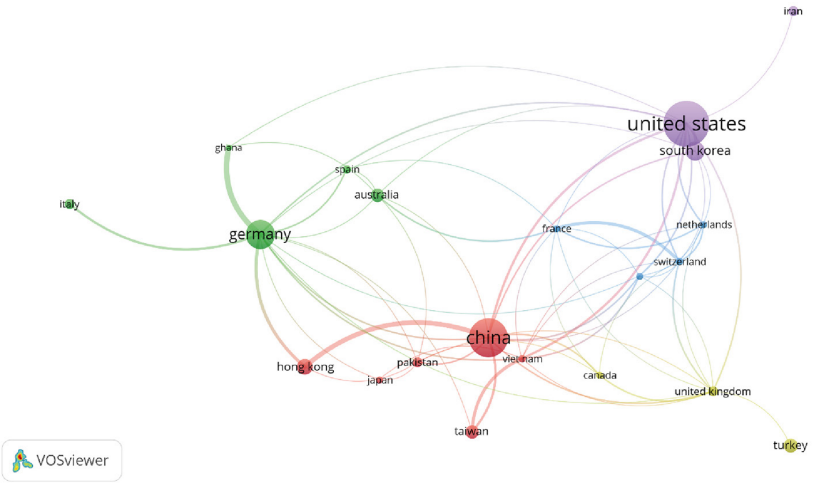
Figure 2 Map Illustrating Collaborative Research Efforts Among Nations



Note. For the color version, please download from the journal's website to identify the information in this figure.

indicating a wide-reaching research partnership that transcends specific geographic boundaries. The strong research traditions of Australia and Germany may enable them to establish effective collaborations with other nations. The grouping of France, the Netherlands, Singapore, and Switzerland in Cluster 3 (blue color) is mainly constituted by European countries with a well-established culture of collaborating on research, and the presence of Singapore from Asia may suggest a growing trend towards Europe-Asia research partnerships. The inclusion of Canada, Turkey, and the United Kingdom in Cluster 4 (yellow color), as well as Iran, South Korea, and the United States in Cluster 5 (purple color), illustrates the diversity in regional or global cooperation models, underscoring the indicator's potential to expand research collaboration and encourage a range of research perspectives on DHL. Countries that are situated in the same region often engage in more extensive research cooperation, along with collaborating on a global scale. The United States, Germany, and China, as advanced countries, are commonly found in sizable collaborative clusters, underscoring their crucial involvement in global research networks. These results give more insight into global research collaboration networks and might assist in shaping future strategies for collaborating on youth DHL.

Key Research Subjects

This section mainly addresses Objective 2: Identifying key research subjects concerning young adults' DHL, providing an analysis of the main topics and themes in DHL research related to young adults. Figure 3 showcases subject statistics that point to Medicine, Social Sciences, Nursing, and Environmental Science as the dominant fields of research in youth DHL.

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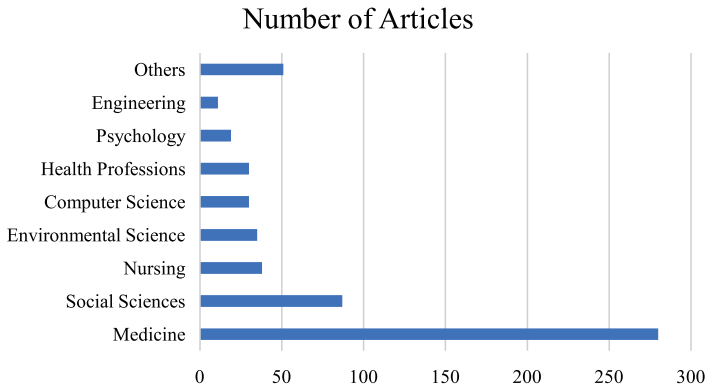
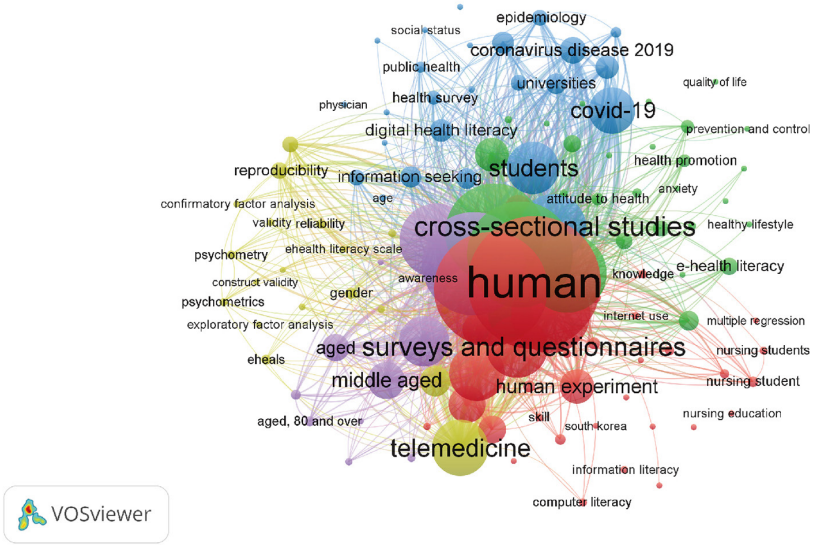
Figure 3 Statistics on Articles Categorized by Subject



The use of VOSviewer for keyword analysis involves selecting keywords that have a minimum frequency of 10 appearances, leading to a total of 122 keywords meeting this requirement. The software search outcome demonstrates that the keywords are organized into five clusters, as presented in Figure 4.

Figure 4 Co-occurrence of All Keywords



Note. For the color version, please download from the journal's website to identify the information in this figure.

Cluster 1 (red color), consisting of 34 keywords, is centered around Digital Literacy and Medical Education themes. The main keywords are attitude, clinical article, computer literacy, curriculum, digital literacy, eHealth, education, health care planning, health literacy, information literacy, internet use, medical education, nursing education, nursing students, and telehealth. The cluster's main areas of interest are digital literacy assessment and medical education,

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involving studies on developing and implementing curricula that include digital literacy for medical and nursing students. Key themes involve student attitudes toward digital tools, the use of electronic health resources, and the significance of digital literacy in enhancing access to and utilization of health information.

Within Cluster 2 (green color), 31 keywords revolve around Health Behavior and Mental Health themes. This cluster includes keywords such as adult, anxiety, attitude to health, college students, depression, eHealth literacy, exercise, health behavior, mental health, quality of life, self-concept, and vaccination. Research in this cluster explores the relationship between DHL and health behaviors along with mental health effects. It also explores how DHL influences attitudes towards health, mental health issues such as anxiety and depression, and behaviors like physical exercise and immunization. Studies commonly involve students and adults who evaluate how their health decisions and quality of life are influenced by DHL.

Public Health and Epidemiology are the main subjects of Cluster 3 (blue color), comprising 25 keywords, which includes keywords such as age, coronavirus disease 2019 (COVID-19), cross-sectional studies, DHL, epidemiology, health education, health survey, infodemic, information seeking, pandemics, public health, sars-cov-2, and social media. The primary focus and substance of this cluster involve research concerning public health crises, particularly the COVID-19 pandemic, encompassing investigations into the impact of DHL on public health results, information-seeking behavior, and health information management during pandemics. In addition, a significant emphasis is placed on utilizing social media and online platforms to disseminate health information and counter misinformation (infodemics).

Cluster 4 (in yellow with 19 keywords) addresses Measurement and Evaluation, incorporating keywords such as confirmatory factor analysis, construct validity, Cronbach alpha coefficient, digital health, eHealth, eHealth literacy scale, psychometrics, reliability, telemedicine, and validity. The main focus of this research cluster is on the development and validation of tools to measure health digital literacy, including investigations into the psychometric properties of tools like the eHealth to ensure their reliability and validity. The cluster is also dedicated to developing measurement instruments for gauging the effectiveness of DHL, suitable for different research and practical settings such as telehealth.

The 13 keywords in Cluster 5 (purple color) are tailored to reach specific demographics and socioeconomics, such as adolescents, aged, awareness, consumer health information, male, middle-aged, socioeconomics, United States, and young adult. This cluster looks at how demographic and socioeconomic factors shape DHL. Research in this cluster investigates variations in digital information literacy and health status across different age groups (e.g., adolescents,

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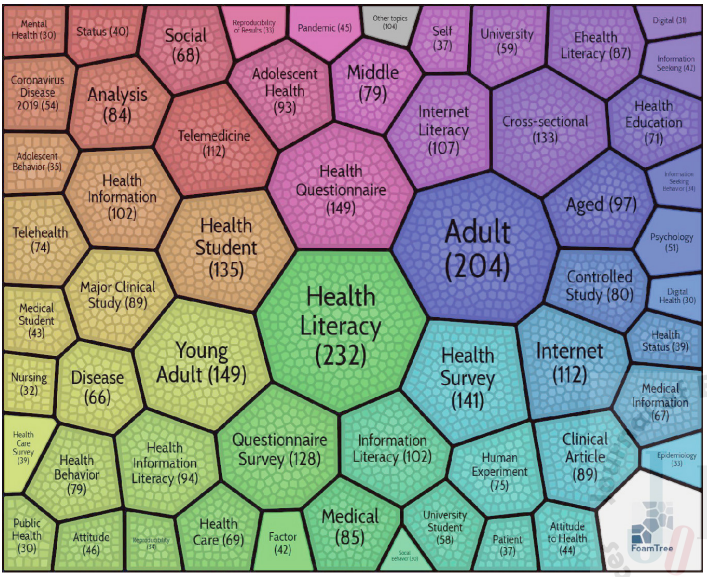
adults, older adults) and diverse socioeconomic backgrounds, as well as studies on consumer health information usage and the influence of socioeconomic status on the accessibility to and comprehension of digital health information.

The Carrot2 tool was utilized to generate a foam tree visualization of keywords for the analysis of significant themes in the research data (Figure 5). Carrot2, an open-source software, is utilized to analyze text data and display theme clusters in a visual format. The utilization of Carrot2 with the Lingo algorithm for thematic clustering by size and color, based on their frequency and relevance, was beneficial in pinpointing key research themes. The chosen parameters consist of a desired cluster count of 30 and a minimum cluster size of 20. With a desired cluster count of 30, the clustering process produced 58 clusters. The number of clusters identified is greater than anticipated, possibly because of the wide range of keywords present in the research data. A higher number of clusters than anticipated could indicate fragmentation in research regarding the DHL of young adults. The cluster size is 30, ensuring that each cluster contains a minimum of 30 documents to prevent the formation of small and insignificant clusters and concentrate on the most significant and popular subjects. The clustering process has achieved significant coverage with 72.6% of the documents being clustered. This indicates that a large portion of the dataset has been organized into relevant clusters, aiding in the identification of key trends and themes within the research field. Several main clusters are as follows.

Figure 5 Visualization of the Article Cluster Foam Tree



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Within the "Young Adult" Cluster (149 documents), the focus is on investigations related to young adults and their distinct health issues, encompassing areas such as health behaviors, attitudes to health, and young adults' access to digital health information. With a focus on health professions students, specifically medical and nursing students, the "Health Student" Cluster (135 documents) discusses the curriculum, necessary skills, and knowledge, along with contemporary teaching methods such as e-learning. The "Internet Literacy" Cluster, consisting of 107 documents, is dedicated to exploring the skill of using the Internet to search for and evaluate health information. Research in the "Health Behavior" Cluster (79 documents) focuses on examining the health behavior of various demographics such as young people, adults, and the elderly. Factors that affect health behavior, such as knowledge, attitudes, and beliefs, are also taken into consideration. The collection of 102 documents under the "Health Information" Cluster delves into the exploration of health information, covering its gathering, assessment, and usage in health-related decision-making. The examination could involve the utilization of information technology within healthcare settings. The group of 54 documents within the "Coronavirus Disease 2019" Cluster focuses on the COVID-19 pandemic, covering topics such as preventative measures, the disease's impact on communities, and the use of health information during crises. Besides this cluster is the group "Mental Health" with 30 documents, reflecting a growing focus on the intersection of mental health issues and the COVID-19 pandemic in recent research. The Cluster labeled "Telemedicine" (112 documents) encompasses research on the swiftly evolving field of telemedicine, which is gaining momentum due to advancements in technology and the effects of the pandemic. These investigations are concentrated on the efficiency, difficulties, and promise of telehealth services.

Keyword analysis using VOSviewer and Carrot2 revealed consistent outcomes concerning the core subjects in the research domain of youth DHL. Both software tools can identify important clusters related to key themes such as mental health, health literacy, health behaviors, and health education. Although the clustering and number of clusters differ, the primary keywords and significant research trends are easily recognizable and alike in both software. Both tools provide an in-depth analysis of research on youth DHL, each offering distinct advantages in terms of approach and analytical depth. The primary difference is in their clustering methods and the detailed level in the clusters. VOSviewer focuses on identifying relationships between keywords through statistical co-occurrence based on their frequency of appearing together in documents. On the other hand, Carrot2 is used as a supporting tool in this research to map

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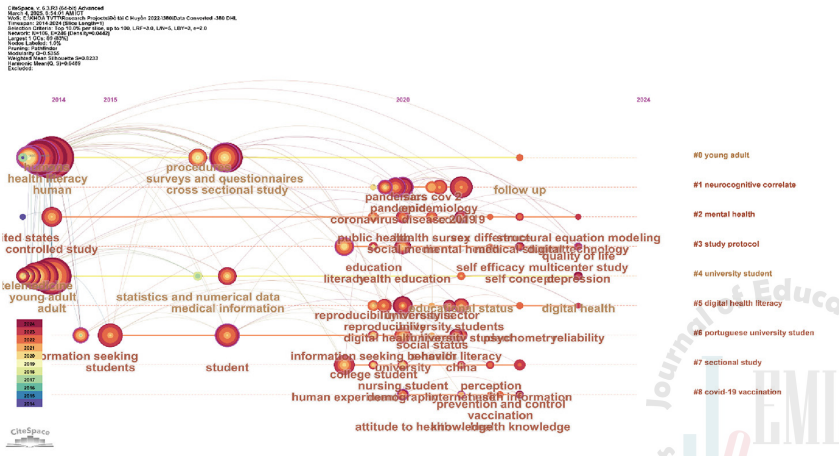
related research themes using the Lingo clustering algorithm, which groups keywords based on semantic similarity to highlight thematic connections. By combining both applications, the analysis offers complementary perspectives: VOSviewer emphasizes co-occurrence patterns, while Carrot2 uncovers semantic relationships. This integrated approach provides both a quantitative mapping of keyword links and a qualitative understanding of thematic content, resulting in a more comprehensive view of research trends in DHL among young adults.

Research Trends

The first part of Objective 3: recognizing emerging and potential research tendencies, examining evolving trends in DHL research related to young adults through a timeline view in Citespace, identifying growth areas and future research opportunities based on thematic clustering in this section, while also addressing the primary publishing sources of articles in Section Publishing Sources of Articles. In this section, Citespace is used to analyze all keywords over time. Figure 6 displays the timeline view map, highlighting key keywords and tracking their progression across clusters over time with the cluster labels on the right and year at the top. Each horizontal line indicates a specific cluster, ranging from #0 to #8. Node size refers to the keyword frequency, links connecting nodes indicate their co-occurrences, node colors represent time, ranging from blue (older) to red (newer), and the position of the node on the timeline indicates when the keyword first emerged. For example, “controlled study” is from an earlier period, while “COVID-19” and “digital health literacy” are more recent topics.

Figure 6 Timeline View Analyzes Research Themes Over Time



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The analysis of keyword clusters in the keyword timeline view chart, along with detailed data on ranked clusters, reveals a notable upward trend in studies related to DHL and young adults from 2014 to 2024. Key clusters within the ranked data indicate a growing focus on assessing and enhancing DHL among students and young adults, especially in the context of the COVID-19 pandemic.

Cluster #0 places significant importance on cross-sectional research, particularly in the area of eHealth literacy among university students. Research in this area often includes using online health information and electronic health literacy to validate measurement tools such as eHealth literacy questionnaires. Both Cluster #1 and Cluster #2 emphasize the significance of DHL during the pandemic, examining the information-seeking behaviors of students and young adults, particularly in Southeast Asia. Especially, the dissemination of the COVID-19 infodemic has raised issues in comprehending and processing information, amplifying the requirement for research on students' capabilities to access and use health information. In these clusters, terms like "depression," "self-efficacy," and "COVID-19" are closely linked, reflecting the pandemic's influence on mental health discussions. Cluster #3 and Cluster #4 further clarify the relationship between DHL and health behaviors among young adults during the pandemic, with particular emphasis on mental health issues and adherence to telehealth practices. In these studies, cross-sectional research methods are commonly employed to investigate the connection between health information literacy and different health results.

Clusters #5 and #6 also reflect the development of tools for measuring DHL among student populations, particularly in assessing the psychometric properties of these scales. This underscores the significance of developing precise and appropriate measurement tools to gain a better understanding of DHL among individuals in this age group. Particularly, Cluster #5 highlights the rapid growth of DHL, especially during the COVID-19 pandemic, as public health increasingly relied on digital tools like telehealth and online health information. Between 2019 and 2021, global health challenges made digital tools like telehealth and online health information crucial, driving the rise of research in this area. Cluster #6 highlights the mental health and academic struggles of Portuguese university students, especially with the shift to online learning during the pandemic. This cluster not only reflects the situation in Portugal but also aligns with a global trend of increasing attention to university students' mental well-being.

Cluster #7, "Sectional Study", focuses on research that collects data at a specific point in time, showing strong activity from 2016 to 2024. The cluster's activity rapidly increased during the COVID-19 period, as cross-sectional studies were used to assess immediate impacts. This cluster is closely connected to

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Clusters #5 (Digital Health Literacy) and #4 (University Student), indicating that cross-sectional studies are often applied to assess DHL and trends within student populations. Cluster #8 is dedicated to examining research on COVID-19 vaccination, with a specific focus on the factors that impact university students' willingness to get vaccinated, particularly in middle-income countries. This demonstrates the link between DHL in youth and their attitudes and behaviors towards public health interventions.

In brief, the graphs and ranking keywords clusters suggest a growing interest in researching DHL among young adults, especially in the context of the COVID-19 pandemic, with a focus on measurement tool development, health literacy, and behaviors related to digital health information. Keywords like "coronavirus disease 2019," "pandemic," and "public health" became dominant in 2020, reflecting the global focus on COVID-19 research. More recently, keywords such as "digital health literacy" and "self-concept" received attention in 2021-2022, highlighting the increasing importance of digital health education and psychological aspects during the pandemic. These trends illustrate evolving research priorities in response to global issues.

Publishing Sources of Articles

The second part of Objective 3: recognizing leading journals identifies key publishing sources to analyze their significance in shaping current research trends. According to statistics from journal databases, the bulk of published studies in journals pertains to library, documentation, and medical and health information management fields (23/37 journals). Figure 7 illustrates the primary sources that have the most published and cited works, all of which are pertinent to library, information, and information management fields. Among the 198 journals, 21 of them published no less than three papers (Figure 7).

Figure 7 Visualization of Citation of Sources of Articles

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The results of the data analysis reveal that the Journal of Medical Internet Research (with 48 articles), International Journal of Environmental Research and Public Health (with 34 articles), Frontiers in Public Health (with 17 articles), and BMC Public Health (with seven documents) are the most popular and frequently cited journals in the field. These journals hold a central position in the network, reflecting a significant level of interest in the field. The top journals contributing to DHL research in our dataset. All of these are open-access journals, which underscores the accessibility of research in this field. Additionally, these journals are primarily within the health sciences, particularly focusing on public health and digital health, indicating that DHL research is largely concentrated within health-related disciplines. This concentration reflects the critical role of digital and health literacy in public health initiatives, while also demonstrating interdisciplinary relevance. Further analysis reveals that 10 top journals with from five to more than five articles each account for a total of 136 articles, which represents approximately 35.79% of the 380 articles in the dataset. This concentration further underscores the dominance of health-related subjects in DHL research, as evidenced by Scopus' analysis, which shows that the medicine, health professions, and nursing sectors together contribute to more than 60% of the total DHL publications. This trend emphasizes the central role of DHL in improving public health outcomes and highlights the importance of digital literacy in the healthcare context.

Discussion

The study employed VOSviewer, Carrot2, and CiteSpace as analytical instruments to present a thorough and detailed overview of the research landscape in the DHL of young adults. Previous research has utilized these tools to conduct bibliometric analysis, with a specific emphasis on pinpointing significant themes and emerging research patterns (Qi et al., 2021; Tian & Chen, 2022; Wang et al., 2022; Yang et al., 2022). Nevertheless, the concurrent application of all three tools in this investigation yielded a more holistic view, especially given the intricate and diverse nature of current research areas. This study not only provides an in-depth, up-to-date analysis of DHL research over the last decade but also advances theoretical discussions by identifying how demographic variables—such as age, education, and socioeconomic status—specifically impact digital health information behavior. Through this, the research reveals emerging theoretical insights that reshape our understanding of DHL, particularly in how younger populations engage with digital health tools post-COVID-19. Furthermore, this study introduces a conceptual framework that links demographic factors with evolving DHL competencies, thereby offering a new

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lens through which future research can explore intersections between digital literacy and health equity.

The study revealed a substantial growth in the volume of articles discussing DHL between 2019 and 2024. The increase can be justified by the mounting need to equip young adults with digital skills and competencies, particularly in the context of the COVID-19 pandemic, when the necessity for accurate and timely health information is more crucial than ever (European Commission, 2014; Yang et al., 2022). Effective utilization of health information by the youth has a dual impact on personal well-being and community welfare (Chen et al., 2023; Kickbusch et al., 2021). The rise is also a result of the expansion of digital resources and internet platforms, enhancing the availability of health-related information. Past research has indicated a transformation in the research emphasis of DHL over time, driven by advancements in information technology and alterations in societal health needs (Qi et al., 2021; Tian & Chen, 2022; Wang et al., 2022).

Research trends in DHL for young adults have shifted noticeably from conventional topics like health literacy and online health information to matters concerning digital platforms and the impact of the COVID-19 pandemic. In earlier times, health information literacy was mainly concentrated on traditional aspects such as health literacy and online health information. Nonetheless, there has been a significant transition in research trends since 2020, with a noticeable increase in the prevalence of keywords related to DHL, telemedicine, and COVID-19 vaccination. The research landscape has shifted toward addressing more intricate challenges in the digital environment rather than just focusing on basic health information access. Studies conducted recently have brought attention to the crucial involvement of young adults, including university students, in addressing worldwide health crises, stressing that in the era of digitalization and pandemics, young adults play a dual role in being impacted by and influencing the dissemination and reception of digital health information. The increasing amount of research on the effects of infodemics and the abundance of cross-sectional studies highlights the pressing necessity to improve DHL among young adults. The sector's progress is consistent with the digital world and global crises such as the pandemic, underscoring its continuous advancement. Analysis of research themes using Citespace demonstrates the consistent growth of topics like digital health and DHL. The World Health Organization (2021) stresses the importance of innovating and employing novel technologies within the health industry in its digital health roadmap for 2020-2025. The analysis by Tian and Chen (2022) on the global research trends in digital health supports this observation.

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In terms of the subjects studied, the bibliometric analysis reveals a prevalence of articles on DHL within the medical domain. A significant portion is also represented by related areas like Health Profession, Nursing, and Psychology, underscoring the close link between DHL and medical matters. This particular interest is brought to the forefront during the COVID-19 pandemic, as there is a growing demand for digital skills in telehealth and online education (Jabeen et al., 2023; Wang & Si, 2023). Themes like "mental health" as a focus in DHL-related research highlight the growing interest in its connection with health literacy, especially amid global challenges like the COVID-19 pandemic, reflecting the finding that aligns with previous research (Jabeen et al., 2023). The results also show a similarity with previous research (Yang et al., 2022), in which fields such as Environmental Science and Computer Science have also recorded a significant increase in publications on DHL, indicating the expansion of research beyond traditional medical domains. In the analyzed dataset, Generative AI-related topics such as ChatGPT or AI-driven health tools were not explicitly present among the identified keywords or thematic clusters. This absence may be due to the time limit of the collected data, as research on the intersection of Generative AI and DHL among young adults is still emerging and may not have been widely incorporated into DHL studies. Additionally, the absence of this topic may be due to the dataset's limitation to Scopus-indexed publications, which might not yet fully capture emerging trends in this area. Exploring Generative AI's impact on DHL, particularly concerning misinformation and the need for enhanced digital literacy skills, while expanding to a meta-analysis of related studies, represents a crucial future research direction.

In terms of research distribution by country and international partnerships, it is evident from the research outcomes that numerous countries, notably European nations and the United States, are engaged in studying DHL, as previously noted (Hao et al., 2024; Jabeen et al., 2023; Qi et al., 2021; Tian & Chen, 2022; Wang et al., 2022; Yang et al., 2022). Countries like the United States play a central role in international research networks, especially in eHealth, DHL, and related fields (Tian & Chen, 2022; Wang et al., 2022; Wang & Si, 2023), leading to stronger ties with countries such as South Korea and Iran (Jabeen et al., 2023). While geographical or cultural proximity might suggest closer collaboration with nearby regions (the red cluster), the thematic alignment and specific research interests, particularly in high-impact areas like DHL, often drive these unexpected patterns of collaboration. Therefore, the clustering reflects shared research priorities rather than geographical proximity. Similarity, recent years have witnessed substantial input from Germany and China, as noted in the study. Furthermore, the inclusion of developing countries like Pakistan and

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Vietnam demonstrates the widening reach of global DHL research. The results of the bibliometric analysis showed robust cooperative clusters, in line with previous research (Qi et al., 2021). There has been a rise in global cooperation between Eastern and Western nations, as seen in the collaboration between Singapore and European countries such as France, the Netherlands, and Switzerland. Specifically, these countries play key roles in data collection from diverse and underrepresented populations, providing valuable insights that enhance the inclusivity and applicability of DHL research. Developing countries often initiate methodological innovation, adapting research designs and technologies to local contexts and challenges. These contributions are essential in ensuring that DHL research reflects a global perspective and addresses the varied needs of different regions. The partnerships formed between developed and developing countries not only facilitate the exchange of knowledge but also build a collaborative environment that enhances research outcomes, leading to more comprehensive and globally relevant findings. This highlights the significance of global collaboration in advancing and exchanging information on DHL, facilitating interdisciplinary and international research cooperation (Jabeen et al., 2023). In addition, the data analysis results emphasize the role of collaborative research in exploring DHL, especially in articles authored by two or more individuals. The significance of collaborative models between researchers, especially those from developing and developed countries, is highlighted in this result, which aims to boost research visibility and aid in the enhancement of university rankings. Furthermore, this finding aligns with Nwagwu's (2024) recommendation that researchers should prioritize partnerships with high-impact institutions and journals to increase the visibility and recognition of their research.

In terms of journals and citations, according to statistics on journal listings, studies focusing on youth DHL are predominantly found in health, library, and information-oriented journals. The Journal of Medical Internet Research and the International Journal of Environmental Research and Public Health are widely read, reflecting a keen interest in the area (Tian & Chen, 2022; Yang et al., 2022). Studies on DHL are increasingly being published in prestigious journals, as highlighted by (Wang et al., 2022), thereby aiding in the development and sharing of knowledge in scientific and practical spheres.

The bibliometric analysis demonstrates the considerable headway made in the study of DHL over the past few years. Research involvement and collaboration among nations are growing, with greater diversity in research fields and a richer variety of research topics. Increasing attention is being given to DHL research, accompanied by enhanced international collaboration and studies on eHealth literacy and digital health. The three analytics tools demonstrated

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consistency in identifying the primary themes regarding DHL, despite differences in their clustering methods and analysis techniques. By combining VOSviewer, Carrot2, and CiteSpace, this study provides a multi-dimensional and detailed perspective on current research trends, particularly in the domains of medical education, health behaviors, and the impact of the COVID-19 pandemic. The simultaneous application of these tools not only offers a more comprehensive and nuanced exploration of the topic but also addresses the inherent complexities of analyzing diverse research patterns, resulting in a holistic view that enhances the understanding of emerging themes and developments in the field.

Conclusion and Recommendations

The interest of scholars in the field of DHL among young adults was demonstrated through the article's analysis of research trends. In the period from 2019 to 2024, there has been a marked increase in the volume of scientific articles discussing the DHL of young adults, particularly in journals within the fields of library, documentation, and medical and health information management. The quantitative analysis results on research collaboration indicate the range of regional and global collaboration models, as well as the potential for broadening the scope of research collaboration and diversifying collaborations among countries and authors. Recent research on youth DHL centers on important themes like DHL assessment, medical education, health behaviors, mental health, public health crises, the development of measurement tools, and details on telehealth technologies, as well as the examination of factors affecting DHL. In addition, keyword research reveals evolving areas of interest over time, highlighting the growing role of information and communication technology in healthcare, as evidenced by the emergence of keywords like eHealth literacy and digital health.

To support the development of research in DHL among young adults, it is advised to consider the recommendations identified through bibliometric analysis as follows. First, trends in research collaboration indicate that developed countries often play important roles in large-scale research collaborations and hold key positions in global research networks. Therefore, fostering international and regional cooperation is crucial for expanding research opportunities and promoting diversity in DHL studies. Strengthening knowledge-sharing networks and author collaborations can further encourage interdisciplinary engagement and innovation in this field. Second, the analysis of research topics highlights the growing significance of emerging fields such as eHealth literacy and digital health. Future research should focus on enhancing the utilization of information and communication technology to improve DHL, integrating theoretical

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advancements with real-world applications, and fostering interdisciplinary collaboration to address the evolving challenges in digital healthcare. Third, expanding research on the organization and management of DHL-related education and training programs is essential for equipping young adults with the necessary digital skills to effectively access and use health information. This requires closer integration of theoretical foundations with practical applications, ensuring that educational initiatives align with healthcare development needs and digital health transformation.

The study, while systematic in its approach, is constrained by its reliance on a limited set of data sources, specifically articles sourced from the Scopus database dating back to 2014. There could be limitations in extending research conclusions on youth DHL broadly. Thus, future investigations should extend the range of data collected from databases.

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Research Article

Factors Influencing Secondary School Teachers' Adoption of Online Professional Development in Taiwan: An Extension of the Technology Acceptance Model

Chiung-Sui Chang

Abstract

The global shift to online learning, accelerated by the COVID-19 pandemic, has significantly transformed teachers' approaches to professional development. This study extends the Technology Acceptance Model (TAM) to examine secondary school teachers' intentions to use OPD programs certified by the Taiwan Ministry of Education. Using structural equation modeling (SEM), 196 valid survey responses from 250 distributed questionnaires were analyzed, yielding a 91% response rate. The findings indicate that TAM constructs—perceived usefulness (PU) and perceived ease of use (PEOU)—strongly influence teachers' intentions to adopt OPD programs. Additionally, external factors such as e-learning content features and interaction with instructors/peers emerged as significant determinants. This study contributes to the TAM literature by integrating these external variables, particularly in a post-pandemic context, and offers practical insights for enhancing OPD design to improve teacher engagement.

Keywords: *E-learning, Online professional development, Technology acceptance model (TAM), Teachers' intention*

Introduction

The global educational landscape has experienced a profound transformation due to the rapid shift toward online learning, a transition markedly accelerated by the COVID-19 pandemic (Eradze et al., 2023; Organization for Economic Cooperation and Development [OECD], 2019). In response to the disruption of traditional instructional methods, higher education institutions worldwide increasingly adopted online modalities to ensure educational continuity. This shift presented educators with unprecedented

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challenges, including maintaining student engagement and learning outcomes, adapting pedagogical approaches to digital formats, and ensuring equitable access to online education (Tang et al., 2020). In this context, online professional development (OPD) has emerged as a vital mechanism for equipping in-service teachers with the digital competencies necessary to navigate evolving educational environments (Elliott, 2017; Meyer et al., 2023; Parsons et al., 2019; Wynants & Dennis, 2018). OPD offers significant potential for enhancing teacher knowledge by connecting educators to a global network of peers who share common professional learning goals and collaboratively exchange resources and expertise.

Taiwan has demonstrated a long-standing commitment to digital learning, actively promoting e-learning initiatives since 1997 under the guidance of the Ministry of Education (MOE). Over the past two decades, professional development (PD) for teachers in Taiwan has shifted from primarily skills-based training models towards more collaborative and peer-supported approaches formats (Hung, 2016; Kong et al., 2017). E-learning platforms, once considered supplementary tools, has become central to in-service teacher education, offering scalability and flexibility necessary to address diverse professional learning needs. Although the existing literature has extensively examined general e-learning systems, it is crucial to distinguish these from online professional development. Unlike general e-learning platforms that cater to broader educational or training goals, OPD programs are specifically designed to support teachers' professional growth by focusing on pedagogical content knowledge, adult learning principles, and practical classroom applications (Brag et al., 2021; de Groot-Reuvekamp et al., 2018; Lay et al., 2020; Mailizar et al., 2021). This distinction underscores a notable gap in the existing literature and highlights the need for research focused explicitly on the adoption of OPD.

Despite Taiwan's proactive digital learning policies, the adoption of OPD has been inconsistent. Although educational reforms since the 1990s have promoted digital integration, these systemic changes have not been uniformly accompanied by increased teacher engagement in OPD. Concerns regarding platform usability, accessibility, and the effectiveness of online formats for sustained professional learning remain prevalent among educators (Esteban-Milat et al., 2018; Hung, 2016; Islam, 2013). As such, a deeper understanding of the factors influencing teachers' willingness to engage with OPD is imperative—especially in light of the accelerating digitalization of education.

This study is situated within the broader context of the global educational digital transformation, where the effective integration of technology into teaching practices is becoming increasingly critical. As educational institutions

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continue to adopt remote and hybrid models, there is a growing demand for professional development programs that are not only effective and accessible but also responsive to the specific needs of educators (Kim & Kim, 2021). Secondary school teachers, in particular, face heightened expectations to develop proficiency in digital tools and integrate them effectively into their pedagogy. Understanding the factors influencing OPD adoption is therefore critical for meeting current professional development demands and for supporting the long-term evolution of teaching in a post-pandemic world.

To explore these factors, this study adopts the Technology Acceptance Model (TAM) (Davis, 1989), a widely validated framework for examining technology adoption across diverse contexts. TAM's core constructs—perceived usefulness (PU) and perceived ease of use (PEOU)—have been successfully applied in numerous educational settings (Al-Adwan et al., 2023; Boateng et al., 2016; Flore & Govender, 2021; Kanwal & Rehman, 2017; Liao et al., 2022). However, limited research has specifically applied TAM to the adoption of OPD, particularly within the Taiwanese context. Furthermore, external factors such as program content quality, interactivity, and institutional support warrant consideration as potential influences on adoption behaviors. This study aims to address this gap by integrating TAM with relevant external variables to investigate the factors influencing Taiwanese secondary school teachers' adoption of OPD.

By identifying key determinants of OPD adoption, this research seeks to contribute valuable insights into the development of more effective and user-centered professional development programs. Ultimately, the findings are expected to inform both local and international educational communities, supporting efforts to enhance the quality, accessibility, and relevance of teacher professional development in the digital age.

Literature Review

Effectiveness of Online Teacher Professional Development

Online professional development (OPD), defined as activities on digital platforms enabling practicing teachers to acquire job-relevant knowledge and skills, has emerged as a significant alternative to traditional face-to-face training (Allen & Seaman, 2016; Elliott, 2017; Flore & Governder, 2021). OPD offers educators the advantages of self-paced learning, transcending temporal and geographical constraints (Yurkofsky et al., 2019), thereby accommodating the diverse needs of teachers managing demanding workloads (Powell & Bodur, 2019). This section examines key factors influencing OPD adoption, focusing on interaction quality, platform usability, and contextual challenges.

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A critical determinant of OPD effectiveness is the quality of interaction within the virtual learning environment. Research consistently highlights the importance of meaningful engagement—between instructors and participants, and among peers—for learner satisfaction, motivation, and persistence (Kucuk & Richardson, 2019; Meyer et al., 2023; Moore & Kearsley, 2012). Collaborative interaction in OPD facilitates deeper understanding and encourages the practical application of knowledge through active learning strategies, such as peer feedback, reflection, and discussion-based activities (Flore & Governder, 2021; Hertz et al., 2022; Lay et al., 2020; K. Y. Liu, 2012; Parsons et al., 2019; Wynants & Dennis, 2018). Furthermore, recent evidence suggests a positive predictive relationship between OPD quality and teachers' engagement (Fütterer et al., 2024).

Despite these benefits, several studies have identified persistent barriers hindering widespread OPD adoption. Teachers frequently express concerns regarding platform usability, accessibility, and the perceived effectiveness of online learning for meaningful professional growth. These concerns are often compounded by systemic issues, including inadequate technological infrastructure, limited institutional support, and a general preference for traditional, in-person professional development formats (Esteban-Milat et al., 2018; Isharyanti et al., 2023).

In the Taiwanese context, the adoption of OPD has been notably limited, despite the government's sustained efforts to promote e-learning in education. This discrepancy underscores the need for research addressing the unique contextual factors influencing OPD uptake among Taiwanese educators. Cultural expectations, policy frameworks, digital literacy levels, and institutional readiness may all play a significant role in shaping teachers' attitudes toward online professional development.

By examining the interplay between interaction quality, usability, accessibility, and contextual barriers, this review lays the groundwork for the development of more effective OPD strategies. Understanding these factors is essential for designing OPD programs that not only meet teachers' professional learning needs but also align with their lived experiences and teaching environments. Ultimately, this review contributes to the broader discourse on effective technology integration in teacher professional development and supports efforts to enhance the quality and accessibility of professional learning in the digital era.

The Technology Acceptance Model

The Technology Acceptance Model (TAM), proposed by Davis (1989), remains a highly influential theoretical framework for examining and predicting

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technology adoption. According to TAM, an individual's intention to adopt and use a technology is primarily determined by two core constructs: perceived usefulness (PU) and perceived ease of use (PEOU). PU refers to the belief that utilizing a particular technology will enhance performance, while PEOU relates to the perception of how effortless the technology is to use (Venkatesh & Davis, 2000). In the context of online professional development (OPD), PU represents teachers' beliefs regarding OPD's effectiveness in improving instructional quality and professional competencies, while PEOU reflects the extent to which educators perceive OPD platforms as user-friendly and accessible.

TAM has been extensively applied within educational settings to understand the adoption of various e-learning systems. For example, Almarashdeh (2016) highlighted the contribution of learning management systems (LMS) to improved learner satisfaction and academic outcomes through accessible and flexible distance education environments. A substantial body of empirical research confirms the significant influence of both PU and PEOU on individuals' intentions to adopt educational technologies (Abdullah & Ward, 2016; Al-Adwan et al., 2023; Islam, 2013; Kanwal & Rehman, 2017; Li & Zhu, 2022; Liao et al., 2022; I.-F. Liu et al., 2010). Notably, PEOU often acts as an antecedent to PU, suggesting that systems perceived as easy to use are more likely to be seen as beneficial. This relationship underscores the critical role of intuitive design in minimizing technical barriers and fostering positive perceptions, particularly for users with varying levels of digital proficiency.

To enhance the model's explanatory power, researchers have incorporated a range of external variables that influence PU and PEOU. Factors such as system reliability, content quality, and the quality of interaction with peers and instructors have been shown to significantly impact technology adoption behaviors (Kumar et al, 2021; Kuo et al., 2013; Leem, 2023; Li & Zhu, 2022; Liao et al., 2022; I.-F. Liu et al., 2010). These considerations are particularly salient in the OPD context, where high-quality, pedagogically relevant content and engaging interaction (de Groot-Reuvekamp et al., 2018; Mulaimovic et al., 2024) are essential to sustain teacher participation and motivation. For instance, well-structured and contextually relevant content can enhance perceived usefulness, while opportunities for collaboration and feedback can create a more supportive learning environment.

Despite TAM's widespread application in educational technology research, its specific use in exploring OPD adoption among Taiwanese educators remains limited. This represents a significant gap, especially considering the distinctive challenges faced by Taiwanese teachers, including infrastructural disparities, skepticism toward online learning, and a preference for traditional, in-person

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professional development formats (Esteban-Milat et al., 2018). While global research has highlighted the impact of external variables on technology adoption, relatively few studies have examined how these variables interact with TAM constructs within Taiwan's educational context. This study addresses this gap by employing TAM to investigate the determinants of OPD adoption among secondary school teachers in Taiwan. In doing so, it integrates relevant external factors—such as content quality, peer/instructor interaction, and system usability—into the traditional TAM framework to provide a more comprehensive understanding of OPD acceptance. This expanded model not only increases TAM's contextual relevance but also aligns more closely with the practical realities of educators navigating digital professional development environments.

E-Learning Content Features and Interaction with Instructors/Peers

Engagement is a critical component of effective e-learning, encompassing a range of interactions that extend beyond learner-learner dynamics. In distance education contexts, engagement occurs across multiple dimensions, including learner-content, learner-instructor, learner-learner, content-content, instructor-instructor, and instructor-content interactions (Moore & Kearsley, 2012; Talebian et al., 2014). Contemporary e-learning theories underscore the centrality of active learner participation in the co-construction of knowledge within meaningful, context-rich environments, often supported by collaborative technologies (Brag et al., 2021).

Learner engagement and satisfaction in online learning environments are consistently influenced by both the quality of instructional content and the degree of meaningful interaction embedded in the learning experience (Clark & Mayer, 2016; Leem, 2023; Meyer et al., 2023; Yu, 2022). High-quality e-learning materials that integrate diverse multimedia elements, interactive simulations, and contextually relevant examples are shown to enhance the comprehensibility of complex concepts and support long-term knowledge retention (Al-Alwan, 2014; Cuesta, 2010; Soydaş Çakır & Akyazi, 2021). Such resources not only enrich the learner experience but also serve to motivate educators participating in online professional development (OPD), a cohort often navigating significant professional and personal demands (Darling-Hammond et al., 2017).

Interactive features within e-learning environments play a pivotal role in promoting learner-content engagement. Tools such as branching scenarios, interactive quizzes, and multimedia explanations deliver immediate feedback, reinforce conceptual understanding, and help sustain learner attention (Mulaimovic et al., 2024; Soydaş Çakır & Akyazi, 2021; Zimmerman, 2012). More broadly, learner satisfaction and learning outcomes are strongly associated with the presence of dynamic interactions involving instructors, peers, and learning

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materials (Ahmed et al., 2023; Baturay, 2011; Fütterer et al., 2024; Kuo et al., 2013; Leem, 2023; Morina et al., 2025; Mulaimovic et al., 2024).

For educators engaged in OPD, collaborative learning opportunities that facilitate peer exchange, the sharing of practical strategies, and the development of professional support networks are especially beneficial (Brag et al., 2021; Sumer, 2021). Meaningful instructor feedback further enhances the learning process by addressing misconceptions, reinforcing key objectives, and offering actionable guidance for classroom application (Ahmed et al., 2023; Baber, 2020; Kim & Kim, 2021; Soydaş Çakır & Akyazi, 2021). To counter the risk of isolation often associated with online learning, OPD programs should incorporate collaborative elements such as discussion forums, group projects, and real-time feedback mechanisms. These features not only foster a sense of community but also promote reflective learning and sustained professional engagement (Joo et al., 2013; Parsons et al., 2019; Powell & Bodur, 2019; Reeves & Pedulla, 2011; Sumer, 2021).

The overall quality of e-learning—encompassing both content and interaction—is positively correlated with learner satisfaction and long-term engagement (Almarashdeh, 2016; de Groot-Reuvekamp et al., 2018; Li & Zhu, 2022). Consequently, OPD initiatives that prioritize pedagogically sound, multimedia-enriched content alongside robust and meaningful interaction are better positioned to foster professional growth, increase participation, and enhance teacher engagement.

Extending TAM for OPD Adoption

This study extends the Technology Acceptance Model (TAM) by incorporating two critical external variables: e-learning content features and interactions with instructors and peers. These factors are hypothesized to influence both perceived usefulness (PU) and perceived ease of use (PEOU), which are the central constructs of TAM, ultimately shaping teachers' behavioral intentions to adopt OPD programs. The inclusion of these variables is supported by prior research, which underscores the importance of content design and interaction in shaping user experiences and perceptions of online learning systems (Ansong-Gyimah, 2020; Cheng, 2014; Moore & Kearsley, 2012; Mtebe & Raphael, 2018; Wong et al., 2024; Zimmerman, 2012). Specifically, engaging and user-friendly e-learning content enhances PEOU by simplifying navigation and accessibility, while also boosting PU by demonstrating clear, practical benefits for professional development (Kumar et al., 2021; Soydaş Çakır & Akyazi, 2021). Similarly, meaningful interactions with instructors and peers contribute to PU by offering collaborative and reflective learning opportunities that align with teachers' pedagogical goals (Meyer et al., 2023; Mulaimovic et al., 2024).

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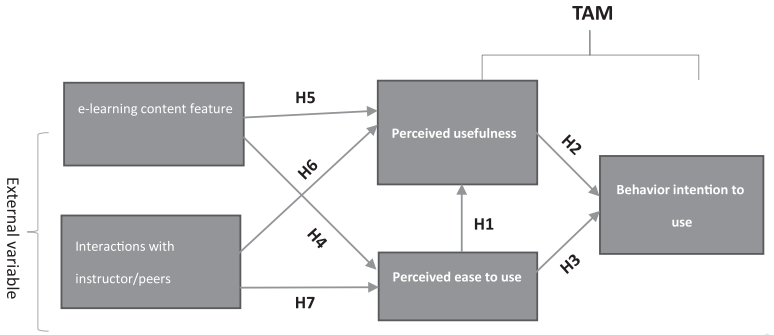
By integrating these external variables into the TAM framework, this study aims to provide a more nuanced understanding of the factors influencing secondary school teachers' adoption of OPD programs in Taiwan. This approach enriches the theoretical understanding of technology acceptance and offers practical insights for designing engaging and effective OPD programs.

Research Model and Hypotheses

Building on the TAM framework and insights from prior studies on technology acceptance, this study proposes a comprehensive research model (Figure 1) to examine the factors influencing Taiwanese secondary school teachers' adoption of OPD programs. The model includes the following key components:

1. Perceived Usefulness (PU): The extent to which teachers believe OPD will enhance their professional competencies and teaching practices.
2. Perceived Ease of Use (PEOU): The degree to which teachers find OPD platforms intuitive and easy to navigate.
3. E-Learning Content Features (External Variable): The quality, relevance, and design of online learning materials, including multimedia elements and interactive components.
4. Interactions with Instructors and Peers (External Variable): Opportunities for collaborative learning, real-time feedback, and meaningful communication within the OPD environment.

Figure 1 The Conceptual Framework



These external variables are expected to significantly influence PU and PEOU, which, in turn, shape teachers' behavioral intentions to adopt OPD. By testing these relationships, the study aims to identify the critical factors driving OPD adoption and provide actionable recommendations for enhancing OPD programs.

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The following hypotheses were developed based on the literature:

- H1: Perceived ease of use will have a significant positive effect on perceived usefulness of OPD programs.
- H2: Perceived ease of use will have a significant positive effect on behavioral intention to use OPD programs.
- H3: Perceived usefulness will have a significant positive effect on behavioral intention to use OPD programs.
- H4: Features of e-learning content will have a significant positive effect on perceived ease of use.
- H5: Features of e-learning content will have a significant positive effect on perceived usefulness.
- H6: Interaction with instructors/peers will have a significant positive effect on perceived ease of use.
- H7: Interaction with instructors/peers will have a significant positive effect on perceived usefulness.

Methodology

Participants

This study involved 250 secondary school teachers from various regions across Taiwan, recruited through purposive sampling. Recruitment was conducted via official school mailing lists and professional teaching networks with the support of educational administrators. Incomplete responses and those exhibiting straight-lining behavior—indicative of low engagement—were excluded from the dataset. After applying these exclusion criteria, a total of 196 valid responses were retained for analysis, yielding a response rate of 91%.

The final sample consisted of 120 female teachers (61.2%) and 76 male teachers (38.8%). The majority of participants (43.9%) were aged between 31 and 40 years, followed by 27% aged 50–59 years. In terms of geographic distribution, 40.8% of participants were from northern Taiwan, 34.6% from the central region, 19.9% from the south, and 4.7% from the eastern region. Most respondents (92.9%) reported prior experience with e-learning, while a minority (7.1%) indicated no formal exposure to school-level online learning activities. Detailed demographic characteristics are presented in Table 1.

Research Context

According to the principles of e-learning (Clark & Mayer, 2016; Herrington et al., 2010), five online educational professional programs have been designed and implemented, and certified by Ministry of Education (MOE) for in-service teacher professional development in Taiwan. Online educational professional

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Table 1 Demographic Profile of the Sample
(*N* = 196)

Profile	Category	Number (*n*)	Percentage (%)
Gender	Female	120	61.2
	Male	76	38.8
Age	Under 30	48	24.5
	31-40	86	43.9
	41-50	53	27
	Above 51	9	4.6
Geography	North	80	40.8
	Central	68	34.6
	South	39	19.9
	Eastern	9	4.7
Formal eLearning experience	Yes	182	92.9
	No	14	7.1

programs provide 16-week online courses designed for teachers to learn about teaching pedagogical and technology knowledge and to use it in K-12 classrooms. When in-service teachers enroll and finish the online courses, they can gain master degree credits for their professional development.

Instrument and Data Collection

We conducted an online questionnaire, with link to the questionnaire sent to the teachers by email. We obtained informed consent from participants of this study. The survey instrument was adapted from validated scales used in previous studies on TAM and online learning adoption (e.g., Al-Alwan, 2014; Bledsoe & Simmerok, 2014; Davis, 1989; I.-F. Liu et al., 2010; K. Y. Liu, 2012; Moore & Kearsley, 2012; Venkatesh & Davis, 2000). The questionnaire consisted of 22 items measured on a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The list of items is shown as Table 2. The items measured the constructs of perceived usefulness (PU), perceived ease of use (PEOU), e-learning content features, interaction with instructors/peers, and intention to use. A pilot test was conducted with 30 secondary school teachers to ensure the clarity and reliability of the instrument. As indicated in Table 2, the Cronbach's alpha values for all constructs ranged from 0.89 to 0.93, indicating high internal consistency.

Data Analysis

To test the hypothesized relationships within the research model, structural equation modeling (SEM) was employed, leveraging its ability to simultaneously evaluate complex relationships among latent variables. The analysis was conducted using SPSS AMOS 22, a widely recognized software for advanced modeling. SEM was chosen for its dual capability to assess the measurement model, which validates the constructs, and the structural model, which examines the relationships among constructs.

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Table 2 Construct and Items in the Questionnaire

Construct	Item	Sources
Perceived usefulness (PU)	1. Using e-learning can enhance my learning efficiency. 2. Rich e-learning resources and supplementary materials can increase my productivity. 3. Using e-learning can improve my motivation and willingness to learn.	Al-Alwan (2014); Davis (1989)
Perceived ease to use (PEU)	1. It would be easy for me to use various e-learning materials. 2. It is easy for me to use the discussion forum of e-learning. 3. It is easy for me to use the e-learning assessment system. 4. It is easy for me to access the utilization of links to external websites to acquire the knowledge I need. 5. Overall, it is easy for me to use e-learning.	Al-Alwan (2014); Davis (1989)
Intention to use (ITU)	1. I would be willing to use e-learning for my professional development. 2. I am willing to recommend others to use e-learning for the professional development. 3. Overall, my willingness to use e-learning for the professional development is very high.	I.-F. Liu et al. (2010); K. Y. Liu (2012); Venkatesh and Davis (2000)
e-learning content feature (ECF)	1. The good quality of e-learning materials can trigger my learning motivation. 2. E-learning materials provide examples and demonstrations can enhance my learning effectiveness. 3. Audio and video streaming e-learning content can be provided for me repeatedly to learn. 4. The richness of e-learning resources would enhance my learning motivation. 5. The up-to-date e-learning content is expected for my learning. 6. The e-learning assessment can be used to reflect my progress. 7. The e-learning content with multimedia can improve my motivation to learn.	Al-Alwan (2014); Bledsoe and Simmerok (2014)
Interaction with instructor/peers (EIP)	1. It can be flexible for me to interact with peers and instructor via e-learning. 2. I can receive the feedback quickly from peers or instructor. 3. Engaging with small group discussions would enhance my effectiveness in my e-learning tasks. 4. To reduce my loneliness, I can actively interact with peers and instructor.	Moore and Kearsley (2012); Zimmerman (2012)

To determine the model's overall fit, several key goodness-of-fit indices were evaluated. The chi-square statistic (χ^2) was used to assess the discrepancy between the observed and predicted covariance matrices. While a non-significant χ^2 suggests a good fit, it is often sensitive to sample size. The

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Goodness-of-Fit Index (GFI) measured the proportion of variance and covariance explained by the model, with values closer to 1 indicating better fit. Similarly, the Comparative Fit Index (CFI) compared the fit of the proposed model to a baseline model, with values above .90 considered acceptable and above .95 indicating excellent fit. Finally, the Root Mean Square Error of Approximation (RMSEA) evaluated the parsimony of the model, with values below 0.08 deemed acceptable and those below .05 reflecting a close fit. These indices collectively ensured that the proposed model adequately represented the observed data, providing a solid foundation for hypothesis testing.

Results

Measurement Model

The measurement model underwent rigorous evaluation to ensure reliability and validity, which are essential for establishing the robustness of the constructs. Reliability was assessed using Composite Reliability (CR) and Cronbach's Alpha. CR values exceeded the threshold of .70 indicating that the items within each construct consistently measured the intended concept (Fornell & Larcker, 1981). Cronbach's Alpha values ranged from .861 to .933, reflecting excellent internal consistency across all constructs. These results confirm that the scale items were reliable and suitable for further analysis.

Convergent validity was established through factor loadings, the Average Variance Extracted (AVE), and CR. Most factor loadings exceeded the recommended threshold of .70, with three items (PEU1, ECF1, ECF2) slightly below but still within the acceptable range for exploratory research (Fornell & Larcker, 1981). These items were retained due to their conceptual relevance and acceptable AVE and CR values for their constructs. AVE values for all constructs were above .50, with values between .69 and .86, demonstrating that the constructs captured more variance from their associated indicators than from measurement error. Additionally, the high CR values supported the constructs' ability to effectively represent their respective dimensions.

The combined evidence from the factor loadings, AVE, CR, and Cronbach's Alpha confirmed the measurement model's reliability and validity. These results indicated that the constructs were appropriately defined and measured, ensuring confidence in subsequent analysis of the structural model.

A summary of reliability and validity results is presented in Table 3, which highlights the robust psychometric properties of the measurement model. Overall, the strong reliability and validity findings reinforced the model's appropriateness.

Furthermore, discriminant validity is supported when the square root of the AVE for each construct is greater than the correlation between that construct

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Table 3 Measurement Model

Construct	Construct code	Factor loading	AVE	CR	Cronbach's α
Perceived usefulness	PU1	.849	.861	.987	.862
	PU2	.843			
	PU3	.885			
Perceived Ease to use	PEU1	.691	.74	.919	.908
	PEU2	.750			
	PEU3	.712			
	PEU4	.733			
	PEU5	.733			
Intention to use (ITU)	ITU1	.833	.857	.947	.891
	ITU2	.919			
	ITU3	.894			
e-learning content feature (ECF)	ECF1	.694	.860	.958	.933
	ECF2	.644			
	ECF3	.743			
	ECF4	.762			
	ECF5	.744			
	ECF6	.783			
	ECF7	.794			
Interactions with instructor /peers (IIP)	IIP1	.73	.79	.912	.904
	IIP2	.84			
	IIP3	.87			
	IIP4	.74			

Note. AVE = average variance extracted; CR = composite reliability

and others (Fornell & Larcker, 1981) and when factor loadings within each construct are higher than those of items in other constructs. The square roots of the AVEs exceeded correlations between constructs (Table 4), confirming strong discriminant validity.

Table 4 Discriminant Validity

	PU	PEOU	IIU	ECF	IIP
PU	.927				
PEOU	.615	.860			
IIU	.682	.667	.925		
ECF	.598	.552	.709	.927	
IIP	.643	.604	.691	.622	.889

Structural Model

The structural model was tested to examine the relationships between the variables. The model demonstrated a good fit with the data ($\chi^2/df = 2.468$, GFI = 0.854, CFI = 0.918, RMSEA = 0.087). The path coefficients were all significant, supporting the hypotheses. A summary of the hypotheses testing results of the standardized path coefficients and path significances is provided is Table 5.

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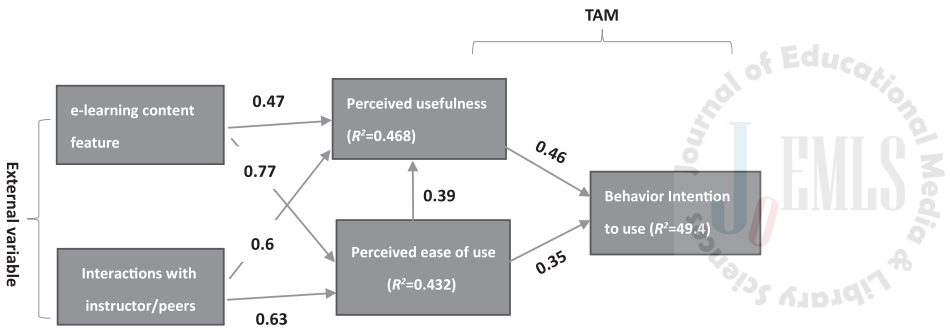
Table 5 Summary of Results Hypothesis Testing

The hypothesis	Results	Support
H1: Perceived ease of use had a positive effect on perceived usefulness.	β = .39, p < .001	Yes
H2: Perceived ease of use had a positive effect on behavioral intention to use OPD programs.	β = .35, p < .001	Yes
H3: Perceived usefulness had a significant positive effect on intention to use.	β = .46, p < .001	Yes
H4: E-learning content features had a significant positive effect on perceived ease of use.	β = .77, p < .001	Yes
H5: E-learning content features positively influenced perceived usefulness.	β = .47, p < .001	Yes
H6: Interaction with instructors/peers had a significant positive impact on perceived ease of use.	β = .63, p < .001	Yes
H7: Interaction with instructors/peers had a significant positive impact on perceived usefulness.	β = .60, p < .001	Yes

The seven hypothesis presented above were tested collectively using structural equation modeling (SEM). These techniques allow for the analysis of both a structural model, i.e., assessing relationship among theoretical construct, and a measurement model, i.e., assessing the reliability and validity of measures. The test of the structural model includes the R^2 values, which represent the amount of variance explained by the independent variables, and estimates of the path coefficients, which indicate the strengths of the relationships between the dependent and independent variables. Together, the R^2 and the path coefficients indicate how well the data support the hypothesized model.

Figure 2 illustrates the R^2 and the resulting path of coefficients of the proposed research model. Perceived usefulness is found to be significantly determined by the two external variables, i.e., e-learning content features, and interactions with instructor/peers, and through the direct effect of perceived ease of use, resulting in a R^2 and the .468. Thus, the above mentioned variable explain 46.8% of variance in the perceived usefulness. Likewise, perceived ease of use is found to be significantly determined by e-learning content feature, and

Figure 2 Results of Path Coefficients



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interactions with instructor/peers, resulting in a R^2 of the .432. Thus, the above mentioned variable explain 43.2 % of variance in the perceived ease of use. Intention to use is significantly determined by the perceived usefulness, and the perceived ease of use, resulting in a R^2 of 49.4. In other words, the combined effects of perceived usefulness and perceived ease of use explain 49.4% of the variance in intention to use.

Discussion

This study aimed to investigate the adoption of online professional development (OPD) programs by secondary school teachers in Taiwan through the lens of the Technology Acceptance Model (TAM), extending its framework by incorporating e-learning content features and interaction with instructors and peers as external variables. The findings provide robust support for Hypotheses 1–3, affirming the established relationships among core TAM constructs: perceived usefulness (PU), perceived ease of use (PEOU), and behavioral intention. These outcomes resonate with a substantial body of existing literature (Abdullah & Ward, 2016; Boateng et al., 2016; Islam, 2013; Kanwal & Rehman, 2017; Khong et al., 2023; I.-F. Liu et al., 2010; Tawafak et al., 2023), reaffirming that PU is a central determinant in teachers' decisions to adopt OPD, grounded in its potential to enhance teaching effectiveness and facilitate professional growth.

The accessibility and functional reliability of well-designed e-learning platforms are key factors influencing both PEOU and PU, suggesting that technical design must be intuitive and responsive to user needs. Furthermore, the extension of TAM through Hypotheses 4–7 revealed that e-learning content and interaction quality exert significant positive effects on both PU and PEOU. Teachers perceived content featuring clarity, multimedia integration, and practical applicability as more effective in meeting their professional learning objectives. Similarly, interactions with instructors and peers—facilitated via various digital tools—enhanced the perceived utility and ease of using the platform. These findings are consistent with existing literature emphasizing the critical role of interaction in fostering engagement, motivation, and satisfaction in online learning environments (Leem, 2023; Shelton & Archambault, 2018; Soydaş Çakır & Akazi, 2021; Sumer, 2021).

A central theoretical contribution of this study lies in its demonstration that OPD adoption is shaped not only by usability but also by pedagogical and social factors. The synergistic effect of high-quality, multimedia-rich content and interactive features underscores the importance of holistic design in promoting both PU and PEOU. This supports the evolving perspective in educational technology research that effective digital learning environments must integrate

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pedagogically sound content and opportunities for meaningful collaboration (Bledsoe & Simmerok, 2014; Darling-Hammond et al., 2017; Kumar et al., 2021; Parsons et al., 2019; Wynants & Dennis, 2018).

From a practical standpoint, these findings yield actionable implications for educational practitioners and policymakers. The strong influence of PEOU suggests that designers must prioritize user-friendly interfaces and seamless navigation. Meanwhile, the mediating role of PU in influencing behavioral intention highlights the necessity of clearly demonstrating OPD's instructional value and relevance to teachers' professional contexts (Akman & Turhan, 2017; Isharyanti et al., 2023; Lay et al., 2020; Sivo et al., 2018).

The importance of interaction is further supported by established frameworks such as Moore's (1989) theory of transactional distance and Rockinson-Szapkiw et al.'s (2016) emphasis on socio-cognitive engagement. Accordingly, OPD programs should accommodate diverse learning preferences through the integration of updated, contextually relevant materials (Baturay, 2011; Cuesta, 2010a) and foster learning communities through structured peer and instructor interaction (Brag et al., 2021; Shelton & Archambault, 2018; Sumer, 2021; Vian et al., 2023).

Contextually, the focus on Taiwan—recognized for its advanced e-learning infrastructure—provides insight into OPD adoption in a digitally mature educational system (Kong et al., 2017). The results suggest that in such environments, the perceived quality of the learning experience, especially content richness and opportunities for social interaction, strongly shapes teachers' perceptions of PU and PEOU. This has broader implications for OPD strategies in similarly developed contexts, where pedagogical depth and community-building features are becoming essential components of successful adoption.

Conclusion

This study contributes significantly to the literature on technology adoption in educational contexts by extending the Technology Acceptance Model to examine secondary school teachers' adoption of OPD programs in Taiwan. The integration of e-learning content features and instructor/peer interaction into the TAM framework offers a more comprehensive understanding of the factors influencing PU and PEOU, both of which are shown to be critical determinants of behavioral intention.

The findings confirm the foundational TAM pathways—specifically, the positive effect of PEOU on PU and the subsequent influence of both constructs on intention to use—while offering new insights into the contextual factors that enhance model applicability within the domain of teacher professional

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development. The inclusion of pedagogical content quality and interactive learning components provides a nuanced perspective that moves beyond mere technical functionality.

Theoretically, this study underscores that effective OPD design is contingent not only on usability but also on pedagogical and social design. High-quality multimedia content and structured opportunities for interaction meaningfully enhance PU and PEOU, ultimately supporting technology adoption and sustained teacher engagement. These insights extend TAM's relevance to professional development contexts and reinforce the importance of considering learner experience holistically.

Practically, the results inform the design and implementation of OPD initiatives by emphasizing the importance of intuitive user interfaces, relevant and updated content, and collaborative learning environments. For educational leaders and policymakers, the study highlights the need to move beyond platform accessibility to include dynamic, teacher-centered instructional design. Additionally, in technologically advanced contexts such as Taiwan, culturally responsive and pedagogically rich OPD programs are essential to fostering teacher participation and long-term engagement.

In summary, this research provides empirical support for an expanded TAM framework tailored to OPD, offering both theoretical refinement and practical guidance. The findings underscore the importance of combining technological usability with pedagogical integrity and interactive engagement to support effective and sustainable professional learning in online environments.

Limitations and Future Research

While this study provides valuable insights into the adoption of Online Professional Development (OPD) among teachers in Taiwan, several limitations warrant acknowledgement. Firstly, the sample, comprising teachers from 20 schools within Taiwan, may constrain the generalizability of the findings to other geographical regions or diverse educational contexts. Given the significant variations in educational systems, cultural dynamics, and technological infrastructure across regions, these contextual factors could differentially influence teachers' perceptions and adoption of OPD programs. Future research should therefore prioritize expanding the sample to encompass teachers from diverse regions, both within Taiwan and internationally, to facilitate a more comprehensive understanding of the factors shaping OPD adoption across varied cultural and educational landscapes.

Secondly, while this study focused on the integration of e-learning content features and interaction with instructors and peers within the Technology

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Acceptance Model (TAM), other salient factors influencing OPD adoption warrant further investigation. For instance, institutional support, encompassing the provision of resources, access to training, and encouragement from school leadership (Flore & Governder, 2021), and technology self-efficacy, reflecting teachers' confidence in their ability to effectively utilize technology, are potentially significant determinants of teachers' willingness to engage with OPD programs. Future research should incorporate these additional constructs to provide a more holistic understanding of the facilitators and barriers to OPD adoption across diverse educational settings. Furthermore, while TAM offers a parsimonious framework, its inherent simplicity may not fully capture the complex socio-technical dynamics influencing adoption. Future research could benefit from employing more nuanced theoretical perspectives, such as the Unified Theory of Acceptance and Use of Technology (UTAUT), to better elucidate the dynamic interplay of individual, social, and contextual influences on OPD adoption.

Thirdly, future research should explore the variations in OPD adoption across different educational levels. This study primarily focused on secondary school teachers; however, the drivers and challenges associated with OPD adoption may differ significantly among teachers at the primary, secondary, and higher education levels due to distinct pedagogical approaches, technological demands, and professional development requirements at each career stage. Investigating these level-specific differences could inform the development of more targeted and contextually relevant OPD programs that address the unique needs of educators at various stages of their professional development.

Finally, given the continuously evolving digital landscape, longitudinal studies are crucial to investigate the long-term impacts of OPD adoption on teaching practices and student outcomes. Such research could provide valuable insights into the sustained effects of OPD on teachers' instructional methodologies and its subsequent influence on student learning experiences. A longitudinal approach would allow for the examination of whether engagement with OPD leads to enduring improvements in pedagogical practices and contributes to enhanced educational quality over time.

In a word, while this study offers important contributions to understanding OPD adoption within the Taiwanese educational context, addressing its limitations through expanded and diversified research designs, the integration of additional relevant variables and more nuanced theoretical frameworks, and the implementation of longitudinal studies will provide a deeper and more comprehensive understanding of the factors influencing teachers' professional development in the digital era. By exploring these avenues for future inquiry, the

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field can contribute to the development of more effective, inclusive, and scalable professional development programs that support teachers globally in their ongoing adaptation to the evolving educational landscape.

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Research Article

Integrating Cultural Literacy and PBL Strategies into 3D Design Courses: A Case Study of University Social Responsibility Practices

Shih-Chieh Hung

Abstract

This study integrates the University Social Responsibility (USR) program with Project-Based Learning (PBL) to examine the impact of a virtual scene production course on students' cultural literacy, interest in 3D design, and practical performance. It also explores the influence of USR values on learning outcomes and students' perceptions of PBL. The study targeted third-year students in the Department of Information and Communication over a 15-week period. Data were collected using a 3D design learning interest scale, a cultural literacy scale, a PBL course evaluation questionnaire, and a 3D design performance assessment. A primarily quantitative approach was used, supplemented by qualitative analysis, to comprehensively assess students' learning outcomes and emotional experiences. Findings reveal that students generally hold a positive attitude toward cultural literacy and 3D design learning, with outdoor practical activities enhancing motivation and reducing learning pressure. Students who demonstrated a strong sense of USR exhibited significantly higher interest and performance in 3D design activities compared to their peers, underscoring the role of USR in fostering learning success. The integration of PBL further strengthened students' learning engagement, social responsibility awareness, and understanding of community and culture. This study offers recommendations for improving 3D design education and cultural literacy while optimizing the PBL learning environment to enhance learning effectiveness and social responsibility.

Keywords: *Cultural literacy, Project-based learning (PBL), University social responsibility, 3D design practical performance, 3D design learning interest*

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Summary

Introduction

As digital technologies continue to evolve, the methods of cultural education are also changing. Traditional approaches—such as reading texts, viewing images, and participating in field trips—often lack interactivity and may not fully support learners' understanding and internalization of cultural knowledge (Hirsch et al., 1987). In contrast, emerging tools such as digital archiving and virtual environments allow learners to explore historical and cultural spaces in immersive and intuitive ways, enhancing both their cultural experience and awareness (Dionisio et al., 2013; Yeh et al., 2020).

In Taiwan, the University Social Responsibility (USR) program promotes partnerships between universities and local communities to address regional challenges. Through themes such as regional revitalization and international engagement, the program encourages educational institutions to combine humanistic values with technological applications (Fu, 2021; Lou, 2022). However, in some historic areas, commercial development has weakened cultural authenticity, turning cultural sites into tourist attractions with little meaningful engagement.

This study focuses on Shennong Street in Tainan, a culturally rich area that faces such challenges. A virtual scene production course was designed to help students engage with local heritage through digital archiving, 3D modeling, and field research. The course aimed to strengthen cultural literacy and technical skills by integrating PBL (project-based learning) strategies and real-world community interaction.

By working as digital archivists and participating in cultural preservation projects, students not only developed their creative and technical abilities but also deepened their understanding of cultural value. The PBL model provided opportunities for hands-on learning, design thinking, and interdisciplinary collaboration, helping students apply classroom knowledge to authentic social contexts.

This study aims to explore how integrating PBL with cultural education and digital technologies can enhance students' learning motivation, 3D design performance, and cultural literacy. It also examines how USR awareness influences students' engagement and professional growth. Through this approach, the research provides new insights into the connections among culture, creativity, and social responsibility in higher education.

Main Objectives

The primary objective of this study was to enhance students' cultural understanding and professional competence by applying experiential and

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community-based learning strategies. Specifically, it sought to investigate the following:

1. To investigate students' current levels of cultural literacy, interest in 3D design learning, and 3D modeling performance through field exploration of a culturally and historically significant old street community.
2. To analyze the differences in cultural literacy, 3D design learning interest, and 3D modeling performance among students participating in a socially engaged course on the basis of varying levels of alignment with USR principles.
3. To explore students' attitudes toward and perspectives on the integration of PBL strategies into USR-based courses after conducting field investigations in a historical and cultural district.

Methods

The study involved 88 junior students from the Department of Information and Communication at a university of science and technology. Over 15 weeks, the students were instructed in 3D modeling techniques in classroom settings and participated in two outdoor fieldwork sessions at the designated cultural site. The course followed the five-step PBL model: problem identification, research, design solution development, presentation, and reflection. A single-group posttest research design was employed, integrating both quantitative and qualitative data. The quantitative instruments included the following:

1. A cultural literacy scale;
2. A 3D design learning interest scale;
3. A rubric-based 3D design performance assessment;
4. A PBL course evaluation questionnaire.

Qualitative data were gathered from students' reflective writing and open-ended responses and analyzed via content analysis to uncover emotional and cognitive insights from the learning experience.

Results

1. Students demonstrated relatively high scores in the affective and cognitive dimensions of cultural literacy, such as respecting local culture and appreciating historical aesthetics. However, behavioral engagement—like actively exploring local history and customs—was comparatively weaker.
2. Learning interest was generally high. The students enjoyed the creative process and expressed optimism toward applying their skills in future projects. Nonetheless, technical difficulties in the early stages slightly hinder learning enjoyment.

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3. In terms of 3D design performance, students showed stronger modeling skills but weaker outcomes in texture mapping and material rendering, indicating the need for further technical reinforcement.
4. Students who aligned more strongly with USR values showed significantly greater learning interest and better performance in modeling, texturing, and material application ($p < .05$), although no significant differences were observed in cultural literacy.
5. Emotional responses improved over time. Initial stress and anxiety ($M = 3.59$) decreased as technical confidence increased. Outdoor fieldwork contributed positively to students' emotional engagement and understanding of the cultural context.

Conclusions

This study integrated PBL into a 3D design course to examine students' performance in cultural literacy, learning interest, and technical application skills. The results indicate that students generally demonstrated strong cultural literacy, particularly in the affective and behavioral dimensions, reflecting respectful and inclusive attitudes toward cultural diversity.

However, students exhibited limited initiative in independently exploring deeper cultural meanings and acquiring new cultural knowledge. This suggests that while current educational models support basic cultural understanding, they may fall short in cultivating the student autonomy and critical thinking necessary for deeper internalization of cultural values.

The study also confirmed the positive influence of USR awareness on students' interest in 3D design and their technical performance. Students who exhibited a stronger sense of social responsibility significantly outperformed their peers in modeling, texture mapping, and material rendering, demonstrating that USR-oriented thinking can serve as a powerful motivator for skill development and engagement (Nye et al., 2012).

Interestingly, no significant difference in cultural literacy was observed between students with and without USR awareness. This finding implies that the development of cultural literacy is shaped by more complex, multifaceted factors—such as personal experience, family background, and broader sociocultural influences—that may extend beyond the scope of a single course.

Nonetheless, all the students, regardless of their USR orientation, scored above average in terms of cultural literacy. This suggests that cultural education has already been effectively integrated into broader curricular and learning environments, supporting students in developing balanced and informed cultural perspectives across diverse value systems.

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The relationship between cultural literacy and technical learning, however, remains insufficiently defined. Future research and curriculum design should further explore how to meaningfully bridge these domains, potentially through interdisciplinary and socially engaged PBL approaches that simultaneously strengthen students' professional skills and cultural responsibility.

PBL implementation had a marked effect on students' 3D design learning. Authentic, real-world learning contexts significantly enhanced students' motivation, technical proficiency, and problem-solving abilities. Field investigations and community engagement activities have contributed to a deeper understanding of the relationship between design practices and cultural environments.

These findings underscore the value of combining hands-on fieldwork with digital design education to improve learning outcomes and promote learner agency (Wen et al., 2010; Thomas, 2000). Despite these benefits, students still encounter challenges in advanced technical areas—particularly UV unwrapping and mapping—indicating the need for additional instructional support for fine-grained operations.

To address these gaps, future course designs should consider incorporating emerging pedagogical innovations such as AI-assisted learning, blended learning models, and short-form instructional videos. These strategies may enhance access to technical resources, lower learning barriers, and improve students' capacity for advanced digital design execution.

Recommendations

On the basis of the findings of this study, several recommendations are proposed for future educational practices, curriculum development, and research:

Integrating PBL More Broadly Into 3D Design and Related Disciplines

The successful implementation of PBL in this study demonstrates its pedagogical value in enhancing student motivation, reducing learning pressure, and promoting experiential engagement. Educators are encouraged to adopt PBL strategies more extensively in 3D design and other creative fields to foster interdisciplinary, student-centered learning environments.

Embed the USR Principles to Enhance Motivation and Technical Proficiency

The positive correlation between USR awareness and students' technical performance underscores the importance of integrating social responsibility education into professional training. Course designers should consider embedding USR concepts into curriculum objectives and project themes to stimulate intrinsic motivation and deepen learning outcomes.

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Develop Long-Term Strategies for Cultivating Cultural Literacy

Since cultural literacy development extends beyond a single course and is shaped by personal, familial, and social contexts, educators should adopt multilayered, long-term strategies. This includes immersive learning experiences, interdisciplinary cultural modules, and community-based projects that support deeper cultural understanding and internalization.

Strengthening the Link between Cultural Learning and Technical Training

Future educational models should aim to more explicitly connect cultural exploration with technical skill development. Aligning cultural literacy with hands-on creative practice not only enriches learning but also fosters socially responsible design thinking.

Address Technical Learning Challenges through Targeted Support

Students face particular difficulties in advanced 3D operations such as UV unwrapping and material mapping. To address this, future courses should incorporate more technical scaffolding, including AI-assisted tutorials, blended learning modules, and short-form instructional videos, to increase accessibility and reduce learning barriers.

Adopt Comparative and Longitudinal Research Designs

Future studies should incorporate control groups or matched-course comparisons to strengthen causal inferences. In addition, longitudinal research can provide insights into the sustained impact of USR and PBL on students' learning, personal development, and career trajectories.

Enhancing Qualitative Data Collection Through Third-Party Observation

To improve the objectivity and analytical depth of future studies, qualitative data collection can be complemented by third-party methods such as video analysis, instructor assessments, or community partner feedback. These tools offer richer perspectives on student behavior and learning engagement.

Exploring Broader Applications of the Instructional Model

The model demonstrated in this study has potential applications beyond 3D design, including in fields such as cultural heritage preservation, digital humanities, and social design. Researchers and educators are encouraged to adapt and evaluate the model across diverse disciplines to promote innovative, socially engaged teaching practices.

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研究論文

文化素養與PBL策略融入3D設計課程中的USR實踐：以某大學社會責任實踐計畫為例

洪士傑

摘要

本研究結合大學社會責任（university social responsibility，簡稱USR）與專題導向學習（project-based learning，簡稱PBL）策略，探討虛擬場景製作課程對學生文化素養、3D設計學習興趣及實作表現的影響，並分析USR精神對學習成效的作用。研究對象為設計相關科系三年級學生，課程為期15週，本研究透過混合研究法，評估學生的學習成效與情感體驗。結果顯示，學生普遍對文化素養與3D設計學習持正向態度，戶外實作活動有助於提升學習動機並減輕學習壓力。此外，具備較強USR精神的學生在學習興趣與技術表現上更為優異，顯示USR精神能促進學習成效。PBL策略則提升學習感知、社會責任意識及文化理解。本研究提供擴展3D設計技術與文化素養教育之建議，並完善PBL學習環境，以提升學習成效與社會責任意識。

關鍵詞：文化素養，專題導向學習，大學社會責任，3D設計實作表現，3D設計學習興趣

緒　論

隨著數位科技的進步，文化教育的形式正逐步轉變。傳統的文化素養（cultural literacy）教育主要依賴文本、影像與實地參訪（Hirsch et al., 1988），但這些方式的互動性有限，難以有效提升學習者對文化內容的理解與內化。近年來，數位典藏（digital archiving）與虛擬環境（virtual environments）已成為文化

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此篇文章之同儕評閱意見報告（Open Point）及導讀簡報（InSight Point）請至本刊網站查閱
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教育的新興工具，透過數位建模與沉浸式技術，使學習者能更直觀地探索歷史文化空間，進而強化其文化體驗與認知（Dionisio et al., 2013; Yeh et al., 2020）。

大學社會責任實踐（university social responsibility，簡稱USR）計畫以「在地連結」與「人才培育」為核心，鼓勵大專院校依據在地需求，結合人文關懷與科技應用，協助解決區域問題並履行社會責任（教育部大學社會責任推動中心，無日期）。自2020年至2022年，該計畫新增「地方創生」與「國際連結」議題，強調以人為本，促進台灣各地均衡發展（傅朝文，2021）。然而，部分歷史文化區域因過度商業化，導致傳統文化內涵逐漸式微，最終形成遊客僅停留於拍照打卡的現象，對文化傳承構成嚴峻挑戰。

為解決上述問題，本研究選擇台南市神農街作為案例，並透過虛擬場景製作課程，探索地方文化數位創意產業的發展潛力。該區歷史文化豐富，但隨著商業化發展，傳統文化內涵逐漸流失（傅朝文，2021）。本課程結合大學師生與在地社區資源，運用3D建模、數位典藏與文化影像分析，讓學生在數位環境中模擬文化場域的建構與保存。透過設計思維與文化資料探查，學生不僅能深化文化知識，也能培養文化素養，並以典藏工作者的視角參與數位文化場域的建構與傳承。此課程不僅回應了歷史文化區域過度商業化的挑戰，也為數位文化教育與創意設計開創新的發展方向。

研究者根據過往相關課程的經驗發現，傳統專業技術課程的目標通常偏重於技術技能的學習，然而，在長達18週的學習過程中，學生可能因單一技能訓練而感到疲乏，進而影響其創意表現。為避免此現象，本課程將學習範疇拓展至戶外，透過實景踏查活動提升學生的學習動機，並以數位典藏工作者的視角貫徹「做中學」的教學理念，強化學生在真實情境中的學習體驗（Mou, 2020）。此方式不僅促進理論與實踐的結合，也提升學生對課程內容的投入度與學習興趣。以神農街為例，儘管各大學的USR計畫提升了該地區的文創價值，許多老屋的修復與改造工程卻在無形中破壞了原有的歷史痕跡，突顯了在文化創新與文化保存之間取得平衡的挑戰。因此，數位文化典藏與3D虛擬環境在文化教育中的應用，不僅能豐富文化學習的多樣性，亦可提升其有效性（Kurdi, 2023），進而成為保護與傳承歷史資產的重要途徑（Dionisio et al., 2013; Mystakidis, 2022）。透過數位典藏技術，學生能夠記錄並保存不同時期的在地風貌，同時透過與實地環境的互動，深化其文化素養，並在過程中反思與分享學習心得，以達成更深層次的文化認知與理解。

參考Chisholm（1998）對課程進行的文化評估，本課程融合了文化意識（cultural awareness）和文化相關性（cultural relevance）的元素，並考量到技術課程應具備的平等獲取機會（equitable access）原則，提供適應性工具以幫助學生參與學習。這樣的設計不僅強調教育的整合性，更透過專題導向學習（project-

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based learning，簡稱PBL）的導入進一步促進了跨領域知識的整合。透過PBL，學生得以將所學知識應用於實際情境中，加強主動學習與問題解決能力，這對於提升學生的專業能力和學習成效具有顯著作用（Mou, 2020; Thomas, 2000）。然而，儘管文化課程與大學教育各學系學程之專業領域的結合，以及PBL與特定領域課程的整合，已成為現代教學中的常見做法，但針對如何促發學生在特定專業領域的學習興趣，以及文化素養如何影響學習成果的探討仍然相對不足。因此，本研究旨在填補這一研究空白，透過實地踏查、數位化保存與PBL教學模式的結合，探討文化素養、專業能力與學習動機之間的關聯，將文化教育帶入虛擬環境，並以PBL學習模式提升學生的技術應用與文化理解能力，最終實現文化教育與數位創意產業的深度結合，進而為未來的教學設計提供啟示與建議。

本研究依託USR計畫，推動師生與社會的連結，瞭解地方所面臨的問題，並結合校內與課程的專業範圍。這不僅使大專院校學生落實大學社會責任的目的，同時藉此實踐過程發揮地方價值，分享更多在地資源於社會。過去，產學合作重視學用落差問題，本研究不僅能實踐地方服務，還能協助地方解決區域問題，促進在校學習與專業的結合。

隨著時代推移，許多具歷史文化意義的場所逐漸失去原有風貌。在本研究關注的專業領域中，3D設計技術，特別是數位建築典藏技術，正逐步成為文化保存的重要手段，確保歷史文化資產得以在數位環境中完整保存，並以立體的方式記錄其不同時期的變遷。對學習者而言，文化素養的培養需長期積累，因此將文化元素融入專業課程，不僅能探究學生的文化素養，亦能研究其對專業學習興趣及成效的影響。這類課程同時促進數位創意產業在地方文化上的應用與發展，使設計者能夠內化知識，提升學習動機，進一步推動軟實力的培養，並實踐USR的核心價值。然而，在專業課程中融入文化議題時，學生是否對專業領域感興趣，以及此興趣能否與文化議題整合以提升學習成效仍具挑戰性。當學生對專業缺乏興趣時，文化議題的引入是否仍能提升學習成果，將是本研究希望探討的核心問題。本研究具體探討以下三項研究目的：

㈠探究學生透過實地踏查具有歷史文化意義的老街社區，在文化素養、3D設計學習興趣與3D模型實作表現上的現況。

㈡分析參與社會服務實務課程的學生，在不同USR精神導向下，其文化素養、3D設計學習興趣與3D模型實作表現的差異。

㈢探討學生在踏查歷史文化老街社區後，對於將PBL策略融入USR課程的態度與觀點。

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二、文獻探討

㈠ PBL專題導向學習策略

專題導向學習策略（PBL）不僅能有效培養學生的實踐能力，還能增強他們的自主學習態度以及對3D設計的信心與興趣（Mou, 2020; Thomas, 2000）。在這一策略下，學生以特定任務為基礎，透過各自的調查方法探究問題並尋找解決方案。PBL以學習者為中心，使學生能夠自行擬定解決問題的策略，從而提升推理能力與創造力（Yu, 2024）。在學習過程中，學生不僅能夠完成具體成果，感受到成就感和自信心的提升（溫嘉榮等，2010；Becerra-Posada et al., 2022）。

PBL融合了真實世界的內容，並依賴教師的引導和明確的教學目標（Farrow et al, 2024; Moursund, 1999）。這種以專案為中心的學習模式促使學生進行長時間的自主學習，進而提升作品的品質（Thomas et al., 1999; Yu, 2024）。例如，王學武（2018）將 PBL策略融入資訊技術實作課程，不僅幫助學生達成既定學習目標，還培養了他們的專業技能、資料收集能力、創造力及資訊科技應用等核心能力。因此，本研究依循PBL的架構，將戶外真實場域引入技術學習課程，旨在促進學生自主學習能力的發揮，並培養其探究及解決問題的能力，從而增強內在動機，提高學習成效。

1. PBL的進行模式

根據Blumenfeld等（1991）與Barrows（1996）的研究，PBL典型的學習流程包含以下五個階段：

(1) 問題情境設定（problem definition）：透過教師提供真實或模擬情境，引導學生界定學習目標與核心問題。

(2) 資訊蒐集與探究（investigation and research）：學生透過資料查詢、討論與實驗，建立知識架構。

(3) 方案設計與執行（solution design and implementation）：學生設計解決方案，進行實作並反覆修正。

(4) 成果發表與反思（presentation and reflection）：學生展示學習成果，並透過同儕與教師回饋進行反思與改進。

(5) 評估與改進（assessment and iteration）：透過自我評估、同儕評估及教師評估，確認學習成效並改進未來學習策略。

在本研究中，PBL的學習活動以台南市神農街為場域，學生透過3D建模專案任務，從文化資料蒐集、創意設計到最終作品發表，培養其文化理解與數位設計能力。

2. PBL的評估要點

PBL的學習成效可透過以下三個面向評估（Hmelo-Silver, 2004; Thomas, 2000）。

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(1)學習成效評估（learning outcomes）：學生是否掌握3D設計技能、文化知識及問題解決能力？

(2)學習過程評估（learning process）：學生在小組討論、資料蒐集及設計過程中的互動情形如何？

(3)學習態度與動機評估（learning motivation）：學生的學習投入程度、學習興趣是否提升？

本研究透過多元評估工具衡量學生的學習成效與PBL策略的影響。使用3D設計學習興趣量表與文化素養量表評估學習興趣與文化素養；並透過PBL課程評估問卷分析USR精神、學習情緒轉變與學習成效；並以3D設計實作表現評量評估學生的技術應用與創新能力。

㈡文化素養與文化認同

多元文化提供批判與反思的契機，使我們從文化差異與包容的層面，深入探討文化認同與融合。台灣歷經不同政權統治，累積豐富的歷史脈絡與多元文化影響，成為多元文化的縮影。文化素養（cultural literacy）強調學習者透過深度學習，發展認知能力、社會情感技能及公民素養。根據OECD與Asia Society（2018），全球素養的核心價值在於尊重人性尊嚴與文化多樣性，學生應具備以下能力（Center for Global Education, 2018, p. 15）：

1. 分析地方與文化議題，理解其歷史背景；
2. 認識並尊重不同文化信仰與身分，欣賞多元視角；
3. 發展跨文化溝通能力，能夠透過文化創作表達個人觀點；
4. 關注社會與文化永續發展，並提出解決方案。

文化知識的理解是文化認同的基礎，透過異文化比較與反思，學習者能釐清自我價值觀，進而強化文化認同（王俊斌，2020）。

1. 文化素養的理論基礎

文化素養的核心概念涵蓋以下三個層面（Byram, 1997; Deardorff, 2006）：

(1)文化理解（cultural understanding）：認識歷史、傳統與社會規範；

(2)文化反思（cultural reflection）：比較自身與異文化的異同，發展批判思維；

(3)文化參與（cultural engagement）：透過創意實踐參與文化活動，培養文化創新能力。

Lähdesmäki等（2022）指出，文化素養可透過具體的創意實踐提升，而文化遺產旅遊則是體驗藝術與文化學習的重要途徑。文化資產不僅承載歷史記憶，也促進文化經濟發展（Perera, 2013）。此外，地方依戀與文化認同感影響居民參與社區文化活動的積極程度（鮑懿喜，2012；Bow & Buys, 2003）。本研究透過3D設計課程，結合文化場域探究，使學生在數位設計的過程中，深化對

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文化環境的理解，並強化文化認同與地方情感連結文化素養（cultural literacy）被Hirsch等（1988）定義為「國家文化的認同」，這一概念強調通過理解文化來促進知識的傳播與發展。李冠儀（2021）的研究也表明，歷史建築的保存能延續地方歷史並增強文化認同。因此，本研究將依據相關的文化素養評估問卷，設計適用的題項，以測量學生在創作過程中對文化場域的探索及其文化認同感。

2. 文化素養的評估與PBL實踐

文化素養的發展須結合實踐與創新。本研究的3D建模課程不僅著重技術學習，更透過文化創意實踐，使學生探索文化場域的歷史價值，並透過設計表達文化意涵。為評估PBL如何促進學生的文化素養與文化認同，本研究將透過以下方式進行分析：

(1)學生的3D設計作品：檢視其對文化元素的應用與技法展現；

(2)學習反思報告：分析學生在探索文化場域時的體悟與價值觀轉變；

(3)問卷調查：評估文化理解、文化參與及文化反思的成效。

文化創意產業在社會發展中扮演關鍵角色，藝術不僅滿足公眾的精神需求，亦促進文化創新（張慶良，2003）。文化創意的核心在於將社區記憶轉化為文化價值，進而提升民眾的文化素養與地方認同（葉欣怡，2022；Hirsch et al., 1988）。透過PBL學習模式，學生能在實際創作中深化文化理解，發展批判性思維，並提升文化參與意願。綜上所述，本研究將透過文化素養評估問卷與PBL課程實踐，探討學生如何在文化場域探索與設計的過程中，加深文化認同，並培養其文化素養與創新能力。

㈢學習興趣與學習動機對3D設計學習表現的影響

學習動機是學習者投入學習活動的關鍵因素，影響其學習態度、持續力及學習表現（Daniel et al., 2024; Tsai et al., 2018）。學習興趣與學習動機密切相關，並在學習與認知情感之間扮演重要的橋樑（Roure et al., 2019）。過去研究指出，興趣可以提升學習者的自主性、參與度、專注力與持續投入度，進而促進學習成效（David & Weinstein, 2024; Frick, 1992）。特別是在技術與設計領域，當學習者對特定主題產生興趣時，會形成強大的內在動力，驅使其主動探索與深化學習（Conard & Marsh, 2014）。

1. 學習興趣的影響因素

學習興趣可由多個因素構成，其中范靜媛與葉建宏（2020）將「喜歡」、「享受」與「投入」視為學習興趣的三大核心要素。此外，學習興趣可分為主題興趣（individual interest）與情境興趣（situational interest），前者指長期對某一主題的穩定興趣，後者則受特定環境或情境影響，並可能隨時間變化（Clinton & van den Broek, 2012; Müller & Louw, 2004）。興趣的激發來源多樣，可能來自學習活動的新奇性，或是在過程中感知到愉悅與挑戰（Ainley et al., 2002; Syarif et al.,

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2024）。當學習者面臨具有挑戰性的任務時，興趣可作為激發潛能的動力，使其更積極地投入學習。此外，成就感與學習興趣之間也存在正向關聯，成功的學習經驗能增強學習者的動機與持續力（Singh, 2011）。

2. 學習動機對學習成效的影響

學習動機可分為內在動機（intrinsic motivation）和外在動機（extrinsic motivation）。內在動機來自學習者對學習內容的興趣與滿足感，而外在動機則可能源自獎勵、評價或成就需求（Howard et al., 2021; Sansone & Thoman, 2005）。當學習者對所學內容充滿熱情並感受到明確的學習目標時，他們的學習動機會進一步增強，從而提高學習表現（Conard & Marsh, 2014; Schunk & DiBenedetto, 2020）。此外，學習興趣與學習領域或職業特質的契合度也會影響學習成果（Nye et al., 2012）。如果學習內容符合學習者的興趣與未來發展方向，他們的投入程度與成就感將會明顯的提升，進而促進學業與職業發展。

3. PBL 在 3D 設計學習中的應用

專題導向學習策略（PBL）是一種以問題解決為導向的學習模式，強調透過實作與探究激發學習者的內在動機。本研究透過PBL教學法，設計3D設計課程，以情境導向方式提升學生的學習興趣與學習動機，並探討其對學習表現的影響。本研究將透過以下方式進行分析：

(1)藉由問卷調查評估學生的學習興趣與動機變化；

(2)以學習表現分析觀察學生在3D設計中的投入程度設計成果；

(3)從學習反思報告檢視學生對學習過程的感受與收穫。

綜上所述，學習興趣與學習動機在3D設計學習中扮演關鍵角色，能有效影響學生的學習態度與表現。透過PBL教學模式，本研究希望能提升學生對3D設計的學習熱情，並強化其解決問題的能力與創新思維。

三、研究方法

㈠研究設計

根據研究目的，本研究架構如圖1所示。自變項包含踏查歷史文化老街、USR精神、PBL學習策略，以探討這些因素如何影響學生的學習成果。依變項則涵蓋文化素養、3D設計學習興趣、3D設計實作表現及課程觀點，以全面評估學生在此學習歷程中的學習成效與態度。其中，USR精神的影響將透過不同USR精神的學生群體間的比較來分析，以檢視社會責任教育在學習過程中的價值。同時，本研究亦關注PBL策略如何增強學生對USR課程的接受度與學習成效，以提供未來教學設計之參考。

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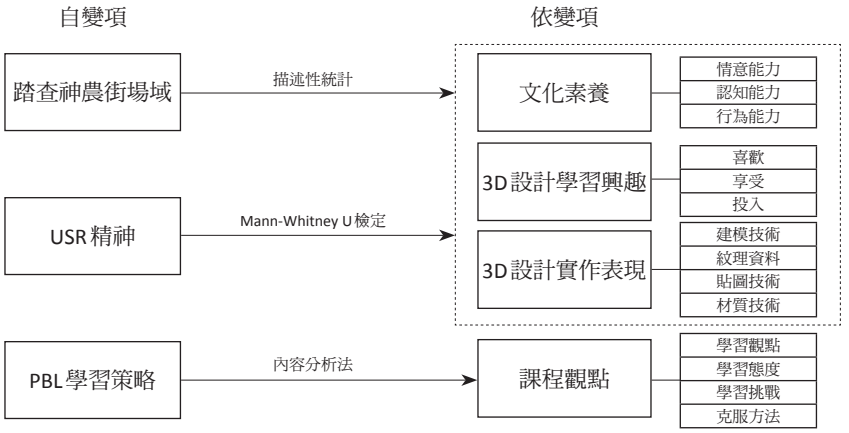
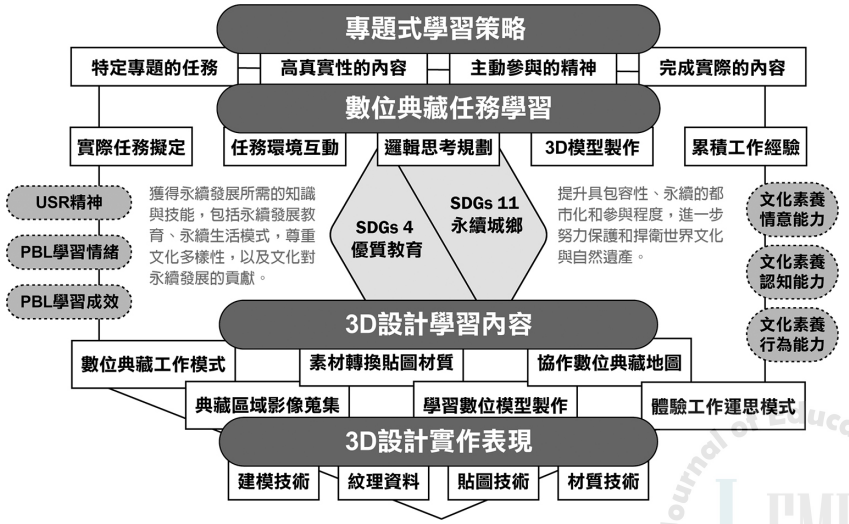
圖1 研究架構圖



本研究旨在建構「虛擬場景製作」3D設計課程透過USR計畫結合PBL專題式學習策略，開發促動大學生文化素養知覺發展的3D設計教材與課程，以進一步協助學習者厚實自身的3D學習經驗，進而成為延展文化意識的學習者。整體課程設計包含三個主要層面，如圖2所示，分別為：

1. 課程內容設計；包括3D設計技法教學、戶外體驗式學習；
2. USR計畫結合PBL導入設計；包括數位化發展社區、數位典藏地圖；
3. 課程評估；包括USR精神、PBL課程評估、文化素養等評估。

圖2 課程設計圖



本研究以個案研究（case study）的方式，針對特定群組進行授課與資料蒐集。由於PBL（問題導向學習）策略研究通常強調實驗分組及前後測分析學生的學習成效，本研究考量到3D設計實作作品的特性、學生學習的最大利益及樣本

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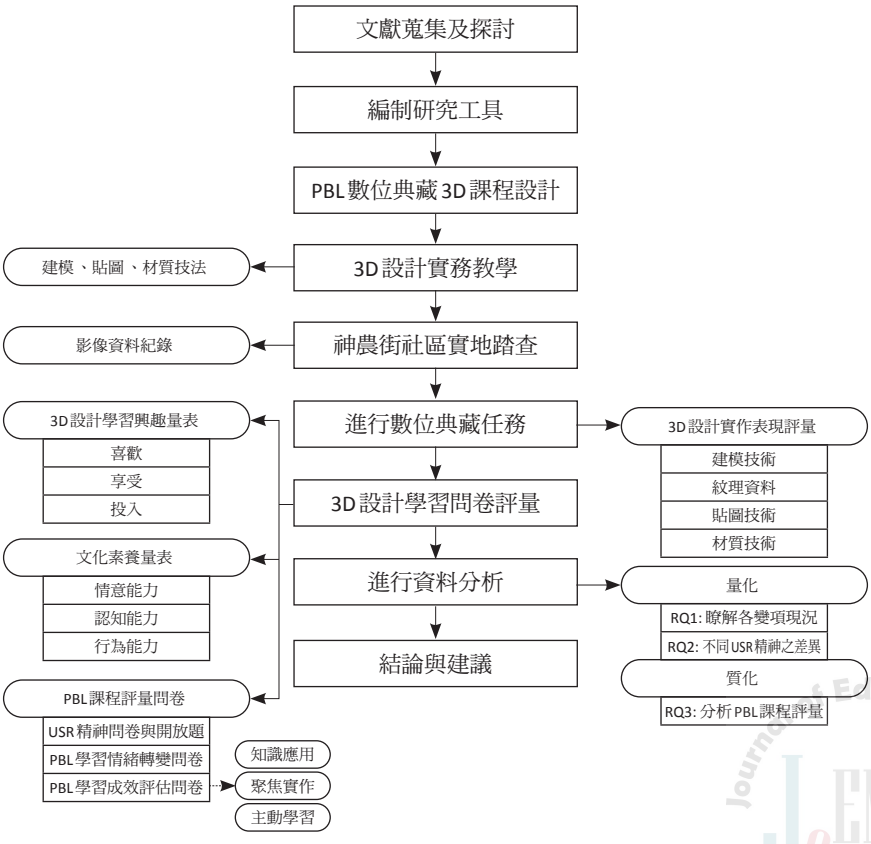
數，並且考慮到數位典藏工作者的工作模式，因此選擇了相同場域規範的分組方式。此外，本研究的PBL專題式學習策略屬於職能型問題解決技法的應用，並非傳統的學習力前後提升模式。如果要求學生對同一模型進行前後測，容易造成學習過程的混亂，且後測結果若優於前測，可能會被誤解為因為反覆練習而非實際學習效果的提升。為了避免這些問題，本研究採用了單組後測實驗設計，以3D設計作品的成績作為評估學生實作表現的標準。

教學活動方面，授課教師傳授3D設計技法，場域踏查則交由場域業師負責進行導覽，參與者皆為一人一組，並以數位典藏工作者之角度，觀察記錄所需之素材與資料，將所收集之影像素材加以製成合適的貼圖。

本研究根據文獻探討選擇適合研究工具，以PBL專題式學習策略規劃USR所推動與社區連結服務計畫，針對某科技大學資訊傳播系虛擬場景製作修課的學生取樣，研究流程如圖3所示。

圖3 研究流程圖



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㈡研究對象與場域

1. 研究對象

本研究以資訊傳播系三年級學生為研究對象，共計88人，這些學生皆已接受過相關設計課程的訓練。本課程「虛擬場景製作」規劃為期15週，主要於室內電腦教室進行技法訓練。透過虛擬場景技法的演練，不僅能激發學生的創意思維與細節關注能力，亦能幫助學生在後續的場域考察時，依據設計規畫進行更精確的資料蒐集。此外，第9週與第16週安排學生至戶外神農街社區進行實地踏查，作為課程實務作品資料蒐集的場域。此課程設計結合理論與實務，使學生能在實際場域中進行資料蒐集與應用，進一步增強其對設計與場域發展的理解。

2. 神農街

位於台南市中西區的神農街（舊稱北勢街）曾是府城主要街道之一，因位處五條港的中心而聞名。街道兩旁遍布古蹟、商行和寺廟，歷史氛圍濃厚，吸引遊客體驗老街風情。二戰後，五條港舊街因都市發展被分割，唯神農街未納入規劃，得以保留清朝時期街道風貌，老屋建築融合了清朝、日治時期及現代修復的元素（曹婷婷，2017）。

目前神農街由當地居民自主維護，並因藝術家進駐而推動文創發展。然而，早期低廉租金吸引遊客的模式逐漸演變為租金上漲與過度商業化，不僅影響當地居民，也阻礙藝術發展，為社區未來發展帶來挑戰（葉晉嘉、謝佳琳，2017）。

本研究之「虛擬場景製作」課程為本文作者所屬機構USR計畫數位街區發展的一部分，該計畫自2020年起致力於建置神農街老街博物館。神農街融合清朝、日治與現代建築元素，歷史文化價值獨特，加上地理位置便利，使其成為本研究的主要場域。

㈢研究工具

1. 3D設計學習興趣量表

本研究將專題式學習（PBL）融入實務課程中，強調情境興趣是由於對事件的投入，受到環境或個人興趣的影響（鄭瑞洲等，2011）。為了深入探討學生的3D設計學習興趣，本研究對范靜媛與葉建宏（2020）設計的興趣量表進行了修改。該量表包含七個問題，透過三個指標——喜歡、享受和投入，來評量學習興趣的狀態。評分採用李克特五點量表，其中1表示「非常不同意」，5表示「非常同意」（Cronbach's α = .927）。

2. 文化素養量表

本研究的文化素養量表參考了陳瀅如（2018）針對遊客文化素養所建構的量表，將文化素養分為情意能力、認知能力與行為能力三個向度進行編制。根

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據研究課程的實際情境，共設計了21道題目，並邀請三位相關領域的專業人員進行修訂和評估，以提高量表的內容效度。由於題項數量較多，根據Little等（2002）的建議，當構面中的題目方向一致且屬於反應型指標時，可以進行項目合併。信度分析顯示，各構面信度均達到 .9，滿足合併條件。因此，將題項進行合併，最終將量表劃分為情意能力、認知能力與行為能力三個構面，並通過結構方程模型進行驗證，結果顯示量表具備良好的結構效度。量表使用李克特五點量表進行評分，1表示「非常不同意」，5表示「非常同意」，以此評估學生的文化素養表現。

3. PBL**課程評估問卷**

由於本研究課程將3D設計作品作為學習成果，雖然技術層面是主要的學習評估指標，但考量到學生的技術尚未完全熟練，本研究透過此評估方式，檢驗學生在排除技術因素後，是否能夠有效運用設計思維，並達成本課程的教學目標。PBL課程的學習評估重點包括：

(1) USR精神：本研究根據本校教學發展中心的PBL學習成效調查問卷進行改編，設計了兩題是非題與三題開放題，旨在檢視學生是否具備USR精神。是非題的內容包括：

a. 數位作品是否能對社會產生影響？

b. 我的3D作品是否有助於該場域的發展需求，我是否願意提供給社區場域使用？

開放題則從不同角度引導學生反思：

a. 請列舉1至3項您在踏查場域過程中發現的相關知識；

b. 在實體場域數位化的過程中，您發現了哪些有助於場域發展的方案？

c. 經由踏查場域，您發現了哪些與該場域相關的知識？

這些題目旨在通過學生的觀察與反思，深入探討他們在場域踏查與3D數位化過程中的體會，以評估其是否具備社會責任意識，以及其對社區發展的實踐能力。

(2) PBL學習情緒的轉變：本研究參考相關文獻（溫嘉榮等，2010；Thomas, 2000）觀察學生在PBL學習過程中的情緒變化，並使用五題設計的李克特五點量表進行評分（1表示非常不同意，5表示非常同意），以評估學生情緒的轉變。具體評估指標涵蓋學習興奮度、焦慮感、成就感等不同情緒層面，以便深入瞭解學生在PBL教學環境中的情感反應。

(3) PBL學習成效的評估：參考相關文獻（王學武，2018；Mou, 2020; Thomas, 2000），編制一套評估PBL策略在學生學習成效上的實際影響之工具。課程以3D設計作為學習成果，雖然技術熟練度為評估的一個重點，但考量到部分學生在技術掌握上尚未達到預期水準，評估焦點將轉

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移至設計思維的運用能力，以更全面地檢驗學生在達成教學目標方面的表現。學習成效的評估涵蓋「知識應用」、「聚焦實作」及「主動學習」三個面向，每個面向設置兩道題目，並採用李克特五點量表進行評分（1表示「非常不同意」，5表示「非常同意」）。此外，本研究邀請三位來自文化教育、設計教育及學習評量領域的專家對問卷內容進行審查，以確保量表的適切性及題目設計符合研究目的。

4. 3D設計實作表現評量

本研究採用PBL專題式學習策略，使學習者能夠面對真實問題，建構知識與問題之間的關聯性，並以學習者為中心進行構思、策略擬定和問題解決，從而提升推理能力，最終完成實際成果（Thomas, 2000）。在評估3D設計的實作表現時，研究者根據數位3D模型製作的四項指標作為評分標準，這四項指標分別為建模技術、紋理資料、貼圖技術及材質技術。每項指標均採用五等級評分標準，依序為「低於預期」、「待加強」、「尚可」、「良好」與「優良」，各指標分數均佔總分的25%。為提升評分標準的有效性，並邀請具3D設計專業背景的專家審閱評分規準，並根據專家建議修正，以確保評分標準的合理性。四項指標的總和即代表作品的總分，滿分為100分。指標評量的詳細說明與細節如表1所示。學生作品範例如圖4所示。

㈣ 資料處理與分析

本研究採用量化分析為主，並輔以質性分析，以全面評估學生在PBL課程中的學習成效及其情感體驗。

表1　3D設計實作表現指標評量說明

20分（低於預期）	40分（待加強）	60分（尚可）	80分（良好）	100分（優良）
1. 建模技術（模型建構的精確程度）				
• 模型外型與主題嚴重不符，結構不完整。 • 布線雜亂，導致明顯的表面變形或摺疊。 • 基礎幾何形狀不清晰，比例嚴重失衡。	• 模型大致符合主題，但仍有較大偏差。 • 布線較完整，但仍可能導致輕微的表面問題。 • 幾何形狀相對清楚，但細節仍不足。	• 模型基本符合主題，與實際外型接近。 • 布線結構較佳，但仍影響表面光滑度。 • 細節雕刻部分略顯粗糙，比例尚可。	• 模型外型良好，細節接近真實物件。 • 布線規劃良好，無明顯變形或摺疊。 • 細節雕刻細緻，比例精準。	• 模型外型完全符合主題，具高度擬真性。 • 布線完整無瑕，表面光滑無變形。 • 細節雕刻極為精細，符合專業標準。
2. 紋理資料（與實景紋理素材是否相符）				
• 未提供紋理資料或紋理與主題無關。 • 紋理材質品質低劣，解析度極低。 • 無法與實際場景建立視覺連結。	• 紋理資料與主題相關，但細節差異大。 • 紋理解析度低，貼圖顆粒感明顯。 • 紋理與實際場景的視覺一致性不佳。	• 紋理資料基本符合實景，細節仍有出入。 • 紋理解析度尚可，但部分區域仍模糊。 • 紋理與實際場景的視覺連結較清楚。	• 紋理資料大部分符合實景，細節完整。 • 紋理解析度高，視覺品質優秀。 • 紋理與實際場景的整體一致性良好。	• 紋理資料完全符合實景，細節高度擬真。 • 紋理解析度極高，無任何模糊或失真。 • 紋理與實際場景的視覺一致性極高。

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表1 3D設計實作表現指標評量說明（續）

20分（低於預期）	40分（待加強）	60分（尚可）	80分（良好）	100分（優良）
3. 貼圖技術（UV 規劃及紋理布置是否正確）				
• 無 UV 拆解，貼圖隨機分布。 • 貼圖錯位嚴重，比例嚴重變形。 • 紋理拼接明顯，影響視覺效果。	• 進行簡單 UV 拆解，但貼圖仍有錯位。 • 部分貼圖變形，紋理拼接不自然。 • 紋理鋪設未考慮材質方向。	• 進行基本 UV 拆解，貼圖大致正確 • 貼圖整齊但仍有局部比例不均。 • 紋理拼接較自然，整體視覺尚可。	• UV 拆解工整，貼圖比例均勻。 • 紋理拼接自然，貼圖品質高。 • 紋理鋪設符合物件結構。	• UV 拆解完美，貼圖比例毫無失衡。 • 紋理拼接無接縫，貼圖高度細緻。 • 紋理鋪設自然，一體成形無瑕疵。
4. 材質技術（材料質地是否正確，如反光、凹凸等）				
• 無材質處理，模型缺乏光影變化。 • 完全無法區分不同材質類型。 • 物件表面呆板，無擬真效果。	• 進行基本材質處理，但區別性低。 • 反光與凹凸效果模糊或錯誤。 • 材質缺乏層次感，整體擬真度低。	• 進行簡單材質處理，可區分材質。 • 反光與凹凸效果基本到位，但仍有缺陷。 • 材質視覺效果接近真實，但仍可改進。	• 材質處理完整，具備正確的反光與凹凸效果。 • 物件表面質感自然，細節豐富。 • 整體擬真度高，但仍可微調部分細節。	• 材質處理精細，光影與質地表現完美。 • 物件表面質感細膩，完全符合真實物體。 • 整體擬真度極高，無瑕疵呈現專業水準。

圖4 學生作品

註：左至右為神農街91號、93號、51號。

1. 量化分析

量化分析使用IBM SPSS Statistics 25進行資料處理，包含描述性統計分析以概述樣本特徵，並透過曼惠特尼U檢定（Mann-Whitney U test）比較不同組別間的學習表現差異，以驗證研究假設。由於學習成效數據未完全符合常態分布，且樣本數較小，因此選擇非參數檢定的曼惠特尼U檢定來進行比較分析，以確保統計結果的準確性與適用性。此外，3D設計實作表現的評估則由授課教師根據標準化評量指標進行評分，涵蓋建模技術、紋理資料、貼圖技術與材質技術等四個維度，以提高評量的客觀性與信度。

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2. 質性分析

質性分析旨在補充量化數據的解釋力，幫助理解學生的學習投入與情感認知變化。研究者採用內容分析法（content analysis），針對學生學習反思報告與課堂回饋文本進行系統性分類與歸納。透過分析文本中的關鍵詞與主題模式，提煉影響學習成效的核心因素（張芬芬，2010）。本研究特別關注學生對 PBL 課程的學習投入、情緒變化及其對課程內容的理解，以獲得更全面的學習歷程洞察。為確保研究工具的信度與效度，質性分析的分類過程則由兩名研究者獨立編碼並交叉比對，以提升資料分析的準確性與可靠性。

透過量化與質性分析的相互補充，本研究不僅驗證PBL對學生3D設計學習表現的影響，也進一步探討學生的學習興趣與文化素養的發展，以提供更完整的學習歷程評估，並作為後續課程優化的參考依據。

四、結果與討論

㈠文化素養、3D設計學習興趣以及3D模型實作表現的現況

表2與表3彙整了文化素養、3D設計學習興趣與3D設計實作表現的描述性統計數據。從文化素養的偏態係數來看，數值的絕對值介於-1.13到0.35之間，峰度則介於-0.91到3.95之間，均符合Kline（2005）所提出的常態分配條件，即偏態係數絕對值小於3且峰度係數絕對值小於10。

1. 文化素養分析

本研究的文化素養量表共包含21道題目，其中：

1. 文化情意能力方面，以「踏查老屋街區時我會欣賞當地文化之美」的題項得分最高（$M = 4.07$），而「踏查老屋街區時我會對當地文化感到好奇」的得分最低（$M = 3.78$），表明學生在文化情意能力的素養程度偏中上。
2. 文化認知能力方面，以「踏查老屋街區時我會尊重與包容當地的文化價值」的題項得分最高（$M = 4.20$），而「踏查老屋街區時我會學習當地的優點並嘗試改變個人價值觀（如：文青氣質）」的得分最低（$M = 3.74$）。整體來看，學生在文化認知能力的素養程度也偏中上。
3. 文化行為能力方面，以「踏查老屋街區時我會遵守當地的文化規則」的題項得分最高（$M = 4.11$），而「製作老屋模型時我會主動瞭解當地的歷史、文化、習俗等」的得分最低（$M = 3.52$）。由此可見，學生在文化行為能力的素養程度同樣偏中上。

從以上量表的結果可知，整體學生在文化素養評估上表現正面，顯示他們對於當地文化的欣賞、尊重與遵循。

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表2 文化素養與3D設計學習興趣之描述性統計

題目	選項（%）					*M*	*SD*	偏態	峰度	排序
	非常不同意	不同意	普通	同意	非常同意					
文化素養（全）						3.89	.58	-.24	1.86	
1. 情意能力（全）踏查老屋街區時……						3.94	.66	-.80	3.49	
我會對當地文化感到好奇	1.1	2.3	27.3	54.5	14.8	3.79	.76	-.60	1.27	15
我會欣賞當地文化之美	1.1	0	13.5	61.4	23.9	4.07	.69	-.94	3.36	5
我會欣賞當地的生活型態	1.1	0	19.3	56.8	22.7	4.00	.73	-.73	2.09	6
我對當地獨特文化感到興趣	1.1	0	20.5	54.5	23.9	4.00	.74	-.69	1.75	7
我能夠察覺當地文化與自身文化的差異	1.1	0	28.4	53.4	17.0	3.85	.74	-.47	1.33	10
我會去比較當地與我自身文化的差異	2.3	1.1	27.3	52.3	17.0	3.81	.81	-.80	1.80	14
2. 認知能力（全）踏查老屋街區時……						3.96	.60	-.54	2.93	
我對當地的文化保持開放的心態	1.1	0	11.4	62.5	25.0	4.10	.68	-1.03	3.95	4
我會尊重與包容當地的文化價值	1.1	0	9.1	56.8	33	4.20	.70	-1.13	3.87	1
我會去理解當地的文化	1.1	0	27.3	47.7	23.9	3.93	.78	-.46	.77	8
我能夠接納當地不同的文化	1.1	0	10.2	58.0	30.7	4.17	.70	-1.08	3.66	2
我會從當地人的角度來思考	1.1	2.3	26.1	52.3	18.2	3.84	.79	-.58	1.03	11
我會學習當地的優點並嘗試調整個人的行為習慣（如：文青行為）	0	0	33.0	51.1	15.9	3.83	.68	.23	-.82	13
我會學習當地的優點並嘗試改變個人價值觀（如：文青氣質）	1.1	2.3	35.2	44.3	17.0	3.74	.81	-.28	.39	18
3. 行為能力（全）製作老屋模型時……						3.78	.61	.35	-.34	
我會主動搜尋當地文化的資料	2.3	3.4	35.2	44.3	14.8	3.67	.86	-.51	.82	20
我會主動瞭解當地歷史、文化、習俗等	2.3	6.8	43.2	31.8	15.9	3.52	.92	-.16	.03	21
我會接觸當地所遇到的對象，並進行交流與學習	1.1	5.7	34.1	42.0	17.0	3.68	.86	-.31	.06	19
我會遵守當地的文化規則	0	0	15.9	56.8	27.3	4.11	.65	-.11	-.61	3
我會多看多問，並表現的謹慎小心	1.1	1.1	29.5	48.9	19.3	3.84	.79	-.44	.77	12
製作完這次的作業後……										
我會想試著去體驗類似的真實文化（例如：在老屋喝咖啡、老屋民宿體驗等）	0	1.1	33.0	44.3	21.6	3.86	.76	.08	-.91	9
我會樂於參與在地的文化交流活動（如新年老街點燈活動、老街音樂會等）	0	1.1	35.2	50.0	13.6	3.76	.69	.15	-.55	16
如果有機會我會樂於參與當地的生活	1.1	2.3	34.1	46.6	15.9	3.74	.80	-.34	.57	17
4. 3D設計學習興趣（全）						3.71	.75	.09	-.54	
我很喜歡這次期末的設計創作模式	0	6.8	18.2	51.1	23.9	3.92	.83	-.58	-.003	1
我很希望老師再讓我進行此類型的設計創作	0	3.4	27.3	43.2	26.1	3.92	.82	-.24	-.67	2
在進行這次創作的過程……										
我覺得很興奮	0	3.4	42.0	36.4	18.2	3.69	.81	-.22	-.78	4
我覺得很快樂	1.1	10.2	35.2	37.5	15.9	3.57	.92	-.21	-.33	5
我覺得很好玩	4.5	8.0	40.9	30.7	15.9	3.45	1.0	-.33	.04	7
我不擔心出錯，不斷地想持續進行創作	0	5.7	26.1	43.2	25.0	3.88	.86	-.32	-.56	3
我很專注	2.3	13.6	33.0	33.0	18.2	3.51	1.01	-.23	-.52	6

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2. 3D設計學習興趣分析

本研究的3D設計學習興趣量表共包含七道題目，其中：以「我很喜歡這次期末的設計創作模式」的題項得分最高（M = 3.92），而「在進行這次創作的過程，我覺得很快樂」的得分最低（M = 3.45），表明學生在3D設計學習興趣上略偏中上，整體表現仍為正面。

總體來看，文化素養與3D設SS計學習興趣的描述性統計結果顯示，學生對於文化的認識與3D設計的學習動機均表現出積極的態度，為後續研究提供了良好的基礎。

3. 3D設計實作評分結果分析

在表3的3D設計實作評分中，整體平均分數為54.73，顯示出學習者的表現偏向中下水平。以下對各評估指標的具體表現進行分析：

(1)在「建模技術」方面，學生的平均得分為65分。評估結果顯示，10.2%的作品能夠「建造符合該主題的外型」，68.2%的作品在模型建構上「與實際外型相似但不完全一致」，而21.6%的作品「未能建造出符合該主題的外型，與實際外型差異甚遠」。這些數據表明，學生在紋理資料的處理上有一定的能力，雖然有部分學生能夠較好地完成模型建設，但仍有約35%的作品未能滿足基本要求，大多數作品仍需在細節上進一步提升。

(2)對於「貼圖技術」的評估，平均分數為50分。評分顯示，25%的作品「具備工整的UV拆解，並做好了貼圖配置」，25%的作品的貼圖技術「僅做了簡易的UV拆解和貼圖配置」，然而，50%的作品的貼圖技術「僅做了簡易的UV拆解，且沒有做好貼圖配置」。顯示，在貼圖技術方面，學生的表現仍有待改善，尤其是貼圖配置的準確性。

(3)在「材質技術」方面，平均分數為47.95分，僅有3.4%的作品「執行了完美且完整的材質處理」，17%的作品「執行了完整的材質處理」，23.9%的作品「執行了簡易的材質處理」，27.3%的作品「僅做了簡陋的材質處理」，而28.4%的作品「毫無執行材質處理」。這些數據顯示學生在材質技術方面的執行力極為不足，幾乎三分之一的作品沒有任何材質處理。

綜合以上結果，學生在3D設計實作中，建模技術、紋理資料、貼圖技術和材質技術的表現存在明顯差異，且各項技術的平均分數均未達到理想水準。這些數據顯示出學生在這些方面的技術上仍有相當大的提升空間，未來的課程設計應著重於針對這些弱點進行更深入的教學與練習。

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表3 3D設計實作表現描述性統計

題目	選項（%）					*M*	*SD*
	低於預期	待加強	尚可	良好	優良		
3D設計實作表現						55.73	19.95
建模技術（模型建構的精確程度）	5.7	15.9	36.4	31.8	10.2	65.00	20.62
紋理資料（與實景紋理素材是否相符）	15.9	19.3	23.9	30.7	10.2	60.00	25.01
貼圖技術（UV規劃及紋理布置是否正確）	28.4	21.6	25.0	21.6	3.4	50.00	24.26
材質技術（材料質地是否正確，例如反光、凹凸等）	28.4	27.3	23.9	17.0	3.4	47.95	23.40

㈡不同USR精神的學生，文化素養、3D學習興趣與3D實作表現之差異

表4顯示了針對USR精神核心問題「我認為3D作品日後有助於該場域的發展需求，我願意提供給社區場域使用」的研究結果。本研究將參與者分為「願意」組（*n* = 78）與「不願意」組（*n* = 10），以探討學生社會責任意識與 3D 設計學習表現之間的關聯性。

表4 各項指標組間比較

評估指標	組別		組間比較		
	具備USR精神（*n* = 78）	不具備USR精神（*n* = 10）	Mann-Whitney U檢定		*p*值
	M ± *SD*	*M* ± *SD*	U統計量	*Z*值	顯著性
建模技術	66.67 ± 20.04	52.00 ± 21.50	224.00	-2.282	.022*
紋理資料	62.56 ± 24.20	40.00 ± 23.09	197.50	-2.603	.009**
貼圖技術	51.79 ± 23.78	36.00 ± 24.59	245.00	-1.956	.049*
材質技術	50.26 ± 23.41	30.00 ± 14.14	195.50	-2.640	.008**
3D學習興趣	3.79 ± 0.72	3.09 ± 0.66	182.50	-2.738	.006**
文化素養情意	3.98 ± 0.57	3.64 ± 1.11	352.00	-0.509	.611
文化素養認知	3.99 ± 0.53	3.71 ± 1.00	354.50	-0.471	.637
文化素養行為	3.81 ± 0.61	3.53 ± 0.60	292.00	-1.298	.194

*p < .05, **p < .01

由於本研究樣本數較小，且變數未滿足常態分布與變異數同質性檢定的假設，因此選用Mann-Whitney U檢定進行組間差異分析。此方法適用於小樣本及非常態分布數據，能有效檢驗兩組中位數之間是否存在顯著差異。

檢定結果顯示，在3D設計學習興趣方面，「願意」組的平均得分為3.79（±0.72），「不願意」組為3.09（±0.66），U檢定的p值為 .006，顯示兩組之間存在顯著差異。這表明，具備USR精神的學生在3D設計學習興趣上顯著較高，反映出社會責任感的提升能有效激發學生的學習動機與興趣。如圖5所示。

進一步分析顯示，具備USR精神的學生在建模技術（p < .005）、紋理資料（p < .001）、貼圖技術（p < .005）、材質技術（p < .001）等實作表現上亦明顯優於不具備 USR精神的學生。然而，在文化素養的表現方面，兩組間並無顯著差

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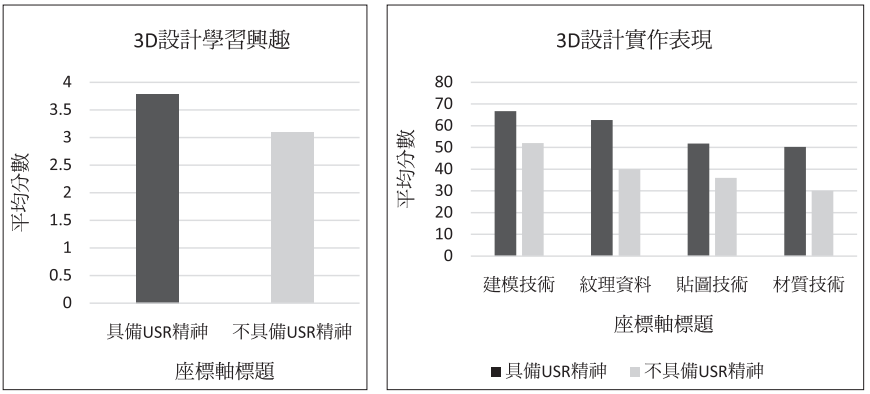
異。這可能說明文化素養的提升需要更長期的教育投入與多層次的學習策略，或受到其他背景因素影響，可從兩組文化素養平均分數皆高於中間值的結果獲得啟發。

綜上所述，USR精神的提升有助於促進學生的學習動機與技術能力，但對文化素養的影響可能較為間接，需透過更深入的教育設計與策略強化及培養。因此，未來課程規劃可考慮整合社會責任教育與文化素養培養，透過更豐富的學習活動與多元評量方式，促進學生的全面發展。

圖5　不同USR精神各指標之差異



㈢ PBL學習策略融入USR課程的看法和觀點

本研究針對學生在PBL課程中融入的教學策略進行學習評量，著重於學習者在3D虛擬場景製作過程中的學習感知、滿足學習需求的程度，以及在學習過程中的認知與情意態度的反思。除了使用量表式題型，亦透過開放式問卷收集學生的自我評價，進行更深入的分析。

1. USR精神核心

在是非題的部分，結果顯示高達92%的學生認為他們的數位作品能對社會產生影響，並有88.6%的學生願意貢獻自己的3D作品幫助場域的發展需求，顯示出學生對社會責任感的認知與實踐意願。在問答題部分，學生展現了對場域知識的深入理解。從表5學生回應的主要內容，顯示學生在PBL學習中不僅獲得了專業技術能力，透過場域相關知識，深化了對社區、文化及社會責任的理解；並藉由數位化過程的反思，能將所學應用於實際場域中。

綜合PBL課程能有效提升學生的學習感知和社會責任意識，並促進他們對社區與文化的深入理解。在USR精神的培養上，學生不僅在技術上有所進步，也能在實際應用中反思自身的學習與成長，未來的課程設計應繼續強調社會責任感的培養並增強學生的實地調查能力，以進一步促進全面的學習發展。

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表5 學習者對於USR精神核心內容歸納

問答題目	類別	學生回應則數	具體回應內容
經由踏查場域發現了什麼場域的相關知識？	歷史與文化	34	1. 瞭解當地歷史（17則）：瞭解當地／神農街歷史、地方古蹟與歷史等。 2. 文化傳承與發展（17則）：保留舊建築、促進經濟、文化活動等。
	建築與環境	28	1. 建築結構和材質（13則）：木造建築、房屋的歷史時期、建築外觀材質等。 2. 房屋細節觀察（15則）：窗戶的形狀、磚頭的時代背景、房屋排列緊密等。
	當地特色與活動	18	1. 地方故事和特色（12則）：水巷的故事、廟宇的故事、當地風情等。 2. 美食與商圈（6則）：水煎包、各種特色店家、商圈活動等。
	實地踏查的價值	10	1. 提升認識與能力（6則）：資料收集/勘察能力、引用資料的技巧等。 2. 觀察細微紋理（4則）：實地觀察細節、模型真實性等。
	無發現	6	例：未發現特別內容、未能進行實地踏查等。
經由將實體場域數位化的過程，我發現有助於場域發展的方案？	數位化應用與效益	52	1. 3D建模和虛擬導覽（31則）：場域3D化讓民眾更瞭解、實景3D模型圖、3D導覽等。 2. 數位化的宣傳和教育（21則）：線上體驗、拍紀錄片、虛擬場景體驗等。
	建築場域觀察與改善	40	1. 建築結構和翻修計畫（22則）：建築整修模擬、翻修計畫評估、房屋翻修等。 2. 場域實地考察（18則）：實地考察感受、現實與虛擬的對比、實體觀察更有感覺等
	提升觀光與社區發展	35	1. 觀光發展和活動舉辦（19則）：吸引觀光、節慶活動。 2. 社區合作與商業發展（16則）：店家合作、商業機會、開設相關課程等。
	個人學習與創意發展	24	1. 學習經驗與技能提升（13則）：資料收集/勘察能力、提升建模技能等。 2. 創意表現和應用（11則）：創意內容創作、藝術建築設計、特色周邊商品等。
	無發現	11	例：未發現特別內容、未能進行實地踏查等。

2. PBL學習情緒

在本研究中，學生在PBL問題導向學習課程中融入的學習策略對於他們的情緒狀態影響顯著。以下是根據調查結果的分析，揭示了學生情緒變化的不同階段。

(1)學習初期的情緒狀態：在課程開始階段，學生感受到的壓力屬於中上水平（M = 3.59, SD = .97）。這表明學生在初次接觸PBL學習時，由於對新學習模式的不熟悉，情緒壓力相對較大。

(2)學習過程中的情緒變化：隨著學生逐漸掌握更多技術與知識，他們的情緒狀態也發生了變化。具體來說：

a. 不安與壓力的降低：隨著技術的提升，學生所感受到的不安與壓力明顯減少（M = 3.59, SD = .97）。這表明技能的掌握對於緩解學習壓力起到了關鍵作用。

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b. 學習態度的改善：學生的學習態度也隨之變得更加積極（*M* = 3.92, *SD* = .71），反映出他們對於學習的興趣和參與度有所增強。

(3) 戶外實作活動的影響：學生普遍認為戶外實作活動對於減輕學習壓力有顯著的正面效果（*M* = 3.90, *SD* = .76）。這類活動不僅有助於實踐學習，也讓學生在學習過程中感受到更多的樂趣和互動。此外，相比於全程在電腦教室進行的課程，戶外實作活動被認為更具吸引力（*M* = 3.85, *SD* = .92），顯示出學生對於多樣化學習環境的偏好，以及戶外實作對於提升學習體驗的重要性。

綜合以上分析，PBL學習策略有效地改善了學生的情緒狀態。從最初的壓力感到逐步適應、減少不安與壓力，再到提升學習態度和情緒，這一過程顯示了技能掌握和學習環境的變化對學生情緒的影響。此外，戶外實作活動的引入，不僅減輕了學習壓力，還增強了學生的學習動機。因此，在未來的PBL課程設計中，應考慮更多元的學習環境和實踐機會，以促進學生的情緒健康和學習成效。

3. PBL學習成效

表6呈現學生在PBL問題導向學習課程的學習成效描述統計，以瞭解學生在PBL課程中的學習效果及其感知。

(1) 知識應用：學生普遍認為他們能有效將學習的知識應用於實際情境中，表現出良好的學習感知。該構面的平均值高於4.03，顯示出學生對於知識轉化為實踐能力的自信和能力認同。

(2) 聚焦實作：平均值介於3.78至3.94之間，這表明學生在進行實作活動時，對於細節和過程的專注程度尚可，但相對於其他構面略顯不足。這或許顯示出學生在具體實作中仍有提升的空間，例如在技術應用、創意實現或團隊協作等方面。

(3) 主動學習：學生顯示出高度的學習主動性，這一構面的平均值同樣高於4.03。這顯示學生在學習過程中能夠主動探索問題、提出問題以及尋找解決方案，展現出良好的學習動機和自我導向能力。

綜合以上三個構面的評估結果，戶外實景模型的製作學習活動在PBL課程中展現出良好的學習感知。知識應用和主動學習的表現尤為突出，顯示出學生對於學習內容的理解和運用能力。而聚焦實作的表現稍顯不足，這表明在今後的課程設計中，應該更加強調具體實作過程中的細節和技巧的培養，以進一步提升學生的全面學習成效。

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表6 PBL問題導向學習課程的學習成效描述性統計

	題 目	選項(%)					*M*	*SD*
		非常不同意	不同意	普通	同意	非常同意		
PBL心情轉換	我對於虛擬場景製作這堂課……						3.71	0.54
	1. 初期感受到壓力	6.8	15.9	30.7	35.2	11.4	3.28	1.08
	2. 當我學到越多的技法，我的不安與壓力越低	2.3	9.1	34.1	36.4	18.2	3.59	0.97
	3. 當我瞭解越多的技法，我的學習態度越積極	0	2.3	22.7	55.7	19.3	3.92	0.71
	4. 安排戶外實景製作有助於我降低學習上的壓力	0	4.5	20.5	55.7	19.3	3.90	0.76
	5. 安排戶外製作的活動，比全程電腦教室的課程來的好	1.1	5.7	26.1	40.9	26.1	3.85	0.92
PBL學習成效	知識應用 製作戶外實景模型……						3.99	0.58
	1. 可促使我整合所學的技法與知識	0	0	19.3	53.4	27.3	4.08	0.68
	2. 製作戶外實景模型，比較能促使我探索3D課程的專業知識	0	0	23.9	48.9	27.3	4.03	0.72
	聚焦實作						3.86	0.67
	3. 比課堂作業更吸引我的興趣	0	3.4	34.1	43.2	19.3	3.79	0.79
	4. 讓我更容易思考整個3D製作流程	0	1.1	26.1	50.0	22.7	3.94	0.73
	主動學習						4.06	0.64
	5. 所發現的問題我會想辦法解決	0	1.1	18.2	55.7	25.0	4.05	0.69
	6. 我很專注，因為我怕做得跟實景不像	0	1.1	19.3	51.1	28.4	4.07	0.72

4. 學習助益與挑戰分析

為了深入瞭解修課學生在課程中的學習助益、收穫、面臨的困難及其克服方式，研究者設計了四個問答題進行探討。表7彙整了學生的回應，進行分析與歸納，並對其進行以下說明：

(1) 對於製作戶外實景模型的學習助益：在問題「我們進行製作戶外實景模型的任務，你覺得對於學習是否有幫助？為什麼？」中，學生的回應主要集中在四個方面：

a. 細節觀察與實作（n = 50）：學生認為此任務幫助提升細節觀察能力，並強調實地踏查對技術成長的重要性（幫助細節的觀察n = 40；實地踏查有助於技術成長n = 10）。

b. 增強洞察力與興趣（n = 29）：此任務讓學生的洞察力和空間認知能力有所提升，並增強了他們對課程的學習興趣（增加洞察力與空間認知能力n = 13、提升學習興趣n = 10）。實際參與製作戶外實景模型的過程，不僅增強了他們的空間認知能力，還提升了對課程的投入感。

c. 整合與應用所學（n = 15）：有15位學生提到，這項任務促使他們整合所學的技術和知識，並將其應用於實際情境中。其中，七位學生強調了自我檢討的重要性，並認識到他們對社會的貢獻。

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表7 學習者對於PBL學習成效內容歸納彙整

進行製作戶外實景模型的任務學習幫助（人次）	
1. 細節觀察與實作（*n* = 50）	幫助細節的觀察（40）、實地踏查有助於技術成長（10）
2. 加強洞察力與興趣（*n* = 29）	增加洞察力與空間認知能力（13）、提升學習興趣（10）、實景參訪的印象（6）
3. 整合與應用所學（*n* = 15）	能整合所學之技術應用於實際場域的製作（15）
4. 自我檢討與社會貢獻（*n* = 7）	自我學習與檢討（4）、社會貢獻與實用性（3）
「製作實景的3D模型」活動最大的學習收穫（人次）	
1. 技術學習與應用（*n* = 60）	學習3D建模（25）、Blender操作（20）、材質貼圖（15）
2. 問題解決及自我提升（*n* = 36）	發現並解決問題（12）、克服困難（10）、增強自學能力（9）、自主學習（5）
3. 成就感與興趣提升（*n* = 24）	獲得成就感（12）、興趣提升（7）、有趣的經驗（5）
4. 實地觀察與歷史文化（*n* = 15）	調查建築細節（7）、瞭解歷史當地文化（8）
製作實景的3D模型」最輕鬆有趣活動（人次）	
1. 建模與技術學習（*n* = 24）	建模相關學習（18）、材質貼圖（4）、技術學習與操作（2）
2. 實地踏查（*n* = 29）	實地調查與參觀（17）、戶外教學（12）
3. 有趣的經驗及成就感（*n* = 24）	有感就感（15）、不同體驗（9）
4. 課堂互動與學習（*n* = 11）	課堂同儕學習（5）、老師教學（6）
5. 無（*n* = 5）	
「製作實景的3D模型」最困難活動（人次）	
1. 材質與貼圖製作（*n* = 55）	UV拆解（12）、材質貼圖（28）、紋理調整（15）
2. 技術與軟體操作問題（*n* = 28）	建模技術（9）、軟體操作問題（13）、學習新技術（6）
3. 細節與模型完整度（*n* = 12）	細節製作（8）、模型完整度（4）
4. 硬體及其他因素（*n* = 10）	電腦硬體問題（7）、環境與設備帶來的學習壓力（3）
「製作實景的3D模型」活動中，克服困難的方法（人次）	
1. 運用線上資源（*n* = 44）	線上搜尋（22）、線上觀看課堂或外部教學影片（22）
2. 同儕與教師支持（*n* = 29）	請教老師（12）、與同學討論（17）
3. 作中學（*n* = 33）	測試與練習（23）、完成後調整（10）
4. 硬體策略或沒有解決（*n* = 8）	更換電腦或定期存檔（5）、沒有克服（3）

d. 自我檢討與社會貢獻（*n* = 7）：部分學生在此過程中進行自我檢討，認識到自己對社會的貢獻。

(2) 學習收穫與挑戰：在針對「在整個『製作實景的3D模型』活動中，你最大的學習收穫、最輕鬆有趣的部分以及最困難的部分是什麼？你是如何克服這些困難的？」的問題中，學生的回應顯示出不同的學習體驗：

a. 學習收穫：

(a) 技術學習與應用（*n* = 60）：學生普遍認為在技術上有很大收穫，尤其是學習3D建模、Blender操作及材質貼圖等，這對他們未來的學習和實作都帶來了幫助（學習3D建模*n* = 25、Blender操作*n* = 20、材質貼圖*n* = 15）。

(b) 問題解決及自我提升（*n* = 36）：不少學生提到能發現問題並加以解決，增強了自學能力（發現並解決問題*n* = 12、克服困難*n* = 10）。

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(c) 成就感與興趣提升（*n* = 24）：完成任務後，學生感受到成就感並增強了對學習的興趣（獲得成就感*n* = 12）。

b. 最輕鬆有趣的部分：

(a) 實地踏查（*n* = 29）：29位學生認為實地踏查是整個活動中最輕鬆有趣的部分，這一過程讓他們有機會親自體驗和觀察，增加了學習的趣味性。

(b) 建模與技術學習（*n* = 24）：部分學生享受建模過程，特別是在材質貼圖和技術操作上。

c. 最困難的部分：

(a) 材質與貼圖製作（*n* = 55）：這被認為是學生面臨的最大挑戰，尤其是在UV拆解和紋理調整上（UV拆解*n* = 12、材質貼圖*n* = 28）。

(b) 技術與軟體操作問題（*n* = 28）：包括建模技術和學習新技術的困難（建模技術*n* = 9）。

(3) 克服困難的方法：在面對挑戰時，學生主要運用了以下策略來克服困難：

a. 運用線上資源（*n* = 44）：44位學生表示他們透過搜尋資料和觀看教學影片來獲得幫助，這對於解決技術問題非常有效（線上搜尋*n* = 22、觀看課堂或外部教學影片*n* = 22）。

b. 同儕與教師支持（*n* = 29）：學生尋求教師的幫助並與同學討論以克服困難（請教老師*n* = 12、與同學討論*n* = 17）。

c. 作中學（*n* = 33）：包括測試和調整過程，33位學生通過反思自己的實作經驗，進行必要的調整和改善，這樣的迭代過程增強了他們的學習效果（測試與練習*n* = 23、完成後調整*n* = 10）。

d. 硬體策略或沒有解決（*n* = 8）：部分學生採取硬體策略來應對問題，如更換電腦或定期存檔（更換電腦*n* = 5）。

透過問答的方式，整體來看，學生普遍認為在製作戶外實景模型的任務中獲得了良好的學習助益，尤其在技術掌握和實作能力上有顯著的提升。雖然在材質與貼圖的製作中面臨挑戰，但透過運用線上資源和自我反思，他們能有效地克服這些困難。這些回應顯示出學生在PBL學習過程中的主動性和韌性，也為未來課程的設計提供了重要的參考依據。

五、結論與建議

㈠ 結論

本研究透過PBL教學法結合3D設計課程，探討學生在文化素養、學習興趣與技術實作能力等多個層面的表現，並進一步分析USR精神在學習成效上的影響。研究結果顯示，學生整體文化素養表現良好，特別是在文化情意與行為層

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面展現出較高的尊重與包容態度。然而，在主動探索文化內涵與學習新知的積極性上仍有待提升，顯示當前的文化教育模式雖能提升學生的文化理解，但仍需進一步強化主動性與批判思考能力，以促進文化價值觀的內化。

另一方面，本研究驗證了USR精神對學生3D設計學習興趣及實作能力的正向影響。具備USR精神的學生在建模技術、紋理貼圖、材質應用等技術層面均顯著優於不具備USR精神的學生，顯示社會責任意識的提升能有效激發學生的學習動機與技術應用能力（Nye et al., 2012）。然而，USR精神對學生文化素養的影響並未呈現顯著差異，這可能反映出文化素養的培養涉及更深層的教育與社會影響，如個人經驗、家庭背景、社會文化等多方面因素。並非僅依賴單一課程即可全面提升，值得注意的是，無論是否具備USR精神，學生的文化素養水平均高於平均值，顯示當前教育體系已普遍將文化素養的培養融入課程設計與學習環境，使學生能在多元文化價值觀的影響下發展相對均衡的文化理解與認知。然而，仍有許多影響因素需要進一步釐清與探討。因此，未來教育應更積極探索如何在文化素養與技術能力之間建立更緊密的連結，如透過專題導向學習與跨領域課程設計等方式，使學生在專業學習的同時深化其文化理解與社會責任意識。

此外，PBL教學策略的應用對3D設計學習帶來了深遠影響。研究發現，PBL模式的真實情境設計能有效提升學生的學習動機、技術應用能力與問題解決能力，特別是在實地踏查與社區連結的過程中，學生能更直觀地理解設計與文化環境的關聯。這一結果進一步突顯了在教學中結合實地實作與數位技術的重要性，從而提升學生的學習成效與學習的主控感（溫嘉榮等，2010；Thomas, 2000）。然而，學生在技術實作方面仍面臨挑戰，特別是在uv拆解與材質貼圖等細緻化操作上，仍需額外的支持。因此，未來的課程設計可進一步引入AI輔助學習、混合學習（blended learning）與短影音技術教學等新興模式，使學生能更便捷地獲取技術資源，進而提升其技術應用能力並降低學習門檻。

㈡學術貢獻、研究限制與未來方向

本研究透過PBL教學法結合3D設計課程，探討文化素養、學習興趣及技術實作能力之關聯，並驗證USR精神對學習成效的影響。研究結果顯示，USR精神能有效提升學生的技術能力與學習動機，但對文化素養的影響較為間接，顯示文化素養的培養需仰賴更深層次的教育策略與長期投入。

1. **主要學術貢獻**

(1) 填補PBL教學法在3D設計教育中的學術缺口：本研究實證了PBL教學法如何應用於3D設計領域，學生普遍對實地學習表現出濃厚興趣，並認為這種學習方式能有效降低學習壓力，並提升學生的學習動機，為未來跨領域學習提供教學參考。

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(2)驗證USR精神對學習成效的影響：研究結果支持USR精神有助於學生技術能力的提升，並強調社會責任教育對專業學習的價值。

(3)探討文化素養培養的挑戰與對應策略：研究發現文化素養的提升不僅依賴課程設計，還涉及長期的教育環境與多層次的學習策略，為未來的文化教育提供參考方向。

2. 研究限制

本研究探討文化教育結合3D設計融入USR社區發展之影響，並透過混合研究進行分析。然而，本研究仍存在部分限制，可能影響結果的解釋與適用性。未來研究可透過控制屬性相符之課程並設置對照組，進行更具比較性的分析，並透過長期追蹤以確認學習成效。此外，在質性數據收集方面，未來可引入錄影分析、教師評估等第三方觀察，加以輔助質性資料的收集與分析，以提升資料的客觀性與分析的深度。

3. 未來研究建議

未來研究可進一步評估本研究模式的適用性，探索其在文化遺產保護、數位人文等領域的應用潛力，以拓展PBL教學法的影響範圍，驗證專案導向學習在不同學科中的成效，並促進跨領域教學創新。此外，可深入分析USR精神的長期影響，探討其對學生學習與職涯發展的影響，以及社會責任教育在特定專業領域中的作用，評估USR精神是否能有效培養學生的社會責任感，並正向影響職涯選擇與專業實踐。

最後，應深化文化素養的培養策略，透過專案導向學習（PBL）、沉浸式學習等方法，針對文化素養不同面向進行更深入分析，以制定更具聚焦的培訓方案，使文化素養與專業技能培養更緊密結合。這不僅能強化學生的文化理解能力，也能提升專業應用能力，進一步促進文化與技術的融合發展。

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Research Article

Exploring the Development of User Experience Research: A Main Path Analysis of Research Citation Networks

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Abstract

With the advancement of technology, users increasingly value experience in all sorts of products and services. To better understand the development of user experience (UX) in academic research, this study employs citation analysis and Main Path Analysis (MPA) to identify the primary trajectories and contexts of knowledge development in UX through relevant literature. The insights aim to serve as a reference for future research. The findings indicate that UX research can be divided into three phases: 1. Development of subjective and objective UX concepts (2004-2009); 2. Establishment of UX conceptual models and understanding public perspectives on these models and measurements (2010-2014); and 3. Improving and refining of UX measurement (2015-2021). This study also presents recommendations for future research in UX and main path analysis.

Keywords: *User experience, Main path analysis, Citation analysis*

Summary

Introduction

The purpose of this study is to analyze the trend of academic research in the field of User Experience (UX), and to explore the trajectory of knowledge accumulation and development in UX research through Main Path Analysis (MPA). Although UX has been widely applied in the practical world, there is still a lack of consensus in the academic field on its definition and measurement, especially in the integration of subjective emotions, aesthetics, and social contexts, which is still a challenge. Therefore, from a bibliometric point of view, this study builds a citation network of UX-related literature and conducts a core knowledge path

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analysis using MPA, in order to clarify the development context and change process of the theoretical and practical evolution in the field.

Literature Review

In the early days of the human-computer interaction field, the concept of UX was related to usability, which was mainly concerned with removing negative usage problems and assisting users in accomplishing tasks (Hassenzahl, 2004). Later on, the concept of UX was gradually separated from usability: while UX usually refers to a more complete and comprehensive user experience, usability gradually became a sub-concept of UX, usually used in the context of whether a system or an interface is effective in achieving the user's goals and satisfies the user. However, UX has many different meanings beyond usability, and there is no clear consensus among scholars and theories (Forlizzi & Battarbee, 2004). For example, some scholars emphasize that UX is not only related to the work environment and tasks, i.e., it should not only be considered as the instrumental aspect of interactive products, but also includes positive experiences and feelings such as aesthetics, enjoyment, and overall goodness (e.g., Hassenzahl & Tractinsky, 2006). However, other scholars disagree on the appropriateness of measuring aesthetics and emotions (Law & van Schaik, 2010). Perhaps due to the lack of consensus, quantitative studies related to usability are still more common in academia, hoping to represent qualitative results in numerical terms through created scales (e.g., Lallemand, Gronier, et al., 2015; Law et al., 2014, etc.), and some scholars even think that the physiological response of a user is more likely to convey the user's state of mind (e.g., Wilson & Sasse, 2004). This has led to the development of many usability scales in related research. However, apart from quantitative usability studies, UX research has been accumulating over the years with different directions of development, which is what this study aims to understand.

MPA is a method of literature analysis that identifies the most dominant citation relationships and development paths in a citation network constructed by cross-citation relationships among works in the literature (Hummon & Doreian, 1989). The purpose of MPA is to track the main knowledge flows in a citation network (Liang et al., 2016), which improves on some limitations of past citation analysis, such as bibliometrics coupling and co-citation analysis, which are less likely to show the development, accumulation and transformation of knowledge in the entire citation network (Hummon & Doreian, 1989). Moreover, a multiple MPA, that is, choosing the main paths with the second highest traversal counts (or third, fourth highest, etc.), is also recommended to show the possible diverse development of knowledge in some fields (Liang et al., 2016).

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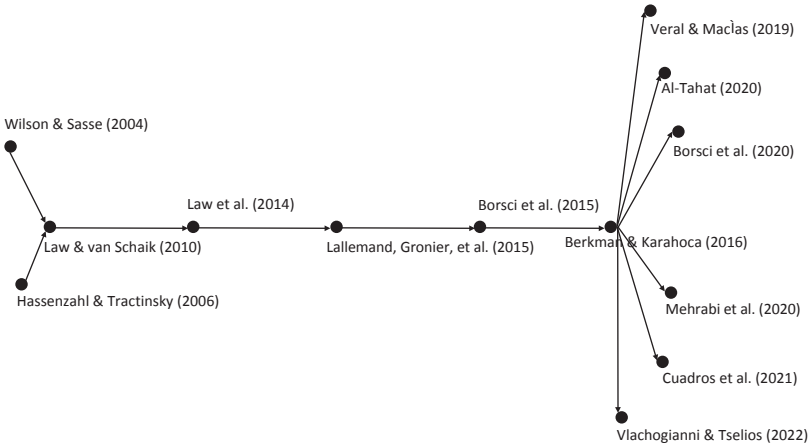
Method

In this study, a total of 2,382 papers between 1996 and October 2021 with "user experience" in the title and author's keywords were retrieved. After processing the retrieved data, a citation network of 824 literature nodes was formed and analyzed by HistCite and Pajek for MPA. Search Path Count (SPC) was used as the traversal count method to establish the overall main paths and supplemented with Multiple Main Paths (MMPs) to examine the direction of diverse knowledge development.

Results

The global main path contains 13 core documents, as shown in Figure 1, which can be divided into three stages of development according to time.

Figure 1 Global Main Path-SPC


Veral & Macìas (2019)
Al-Tahat (2020)
Wilson & Sasse (2004)
Borsci et al. (2020)
Law et al. (2014)
Borsci et al. (2015)
Law & van Schaik (2010)
Lallemand, Gronier, et al. (2015)
Berkman & Karahoca (2016)
Hassenzahl & Tractinsky (2006)
Mehrabi et al. (2020)
Cuadros et al. (2021)
Vlachogianni & Tselios (2022)

In the first phase (2004-2009), the subjective and objective aspects of UX are explored, and it can be seen that the subjective and objective concepts and measurements of experience have been emphasized, respectively. For example, Wilson and Sasse (2004) attempted to use psychophysiological indicators to objectively measure the user's state of mind, while Hassenzahl and Tractinsky (2006) emphasized that UX should combine functionality, aesthetics, and fun, i.e., it should incorporate subjective and objective measurements of emotions and feelings; and it should also consider the dynamics, uniqueness, and contextualization of the experience, which had a profound impact on subsequent research.

The second phase (2010-2014) focused on UX measurement and modeling, where researchers attempted to bring together the subjective and objective nature of UX from the previous phase and hoped to measure it and incorporate it into a researchable scope. Law and van Schaik (2010) proposed a model of UX

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that blended practical and hedonic constructs, and Law et al. (2014) followed up with a questionnaire survey to investigate the HCI (Human Computer Interaction) field's attitudes towards UX measurement. They found that researchers generally held positive attitudes towards quantitative scales. Lallemand, Gronier, et al. (2015) further investigated the views of UX practitioners on UX definitions and measurement, finding that the overall understanding of UX has become more mature, but there is still no unanimous consensus on the quantitative and qualitative measurement methods.

The third phase (2015-2021) focuses on the empirical validation and application of UX measurement tools. For example, Borsci et al. (2015) compared the validity of three scales (SUS, UMUX, and UMUX-LITE) and found that all of them can be used as rapid assessment tools, while Berkman and Karahoca (2016) verified the reliability and sensitivity of the UMUX and the UMUX-LITE from a psychometric perspective. Other literature extended this direction, such as Al-Tahat (2020), who translated UMUX into Arabic to enhance the scale's applicability in different cultural contexts. Borsci et al. (2020) applied UMUX-LITE to healthcare technology assessment and combined it with the NPS (Net Promoter Score) to enhance UMUX-LITE's flexibility of application. In addition, Cuadros et al. (2021) developed the UXQ questionnaire to assess the quality of remote teaching experiments, and this also reflects the expansion of the UX measurement application landscape. Some of the studies in this phase are relatively recent and therefore do not yet have many citations and are less likely to show clear future developments. However, most of these studies continue the theme of measurement (mostly with UMUX or UMUX-LITE); therefore they constitute a reasonable direction for future development.

In addition to the global main path, this study also presents multiple main paths of the top 10% of the largest traversal counts for analysis, comprising in a total of 29 studies, forming two branching paths, as shown in Figure 2 and Figure 3: one starting with Lallemand, Gronier, et al. (2015), which explores the extension of the UX definition and measurement development, such as application studies by Chou (2018) and J.-S. Lo et al. (2019); and the other with Borsci et al. (2015) as a starting point, focusing on scale comparisons and practical application areas such as UX assessment in educational platforms, cashier-less or checkout-free stores, and medical technology. The multiple main paths further illustrate the trend of cross-domain applications and diversification of measurement tools in UX research in recent years.

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Figure 2 Multiple Main Path A

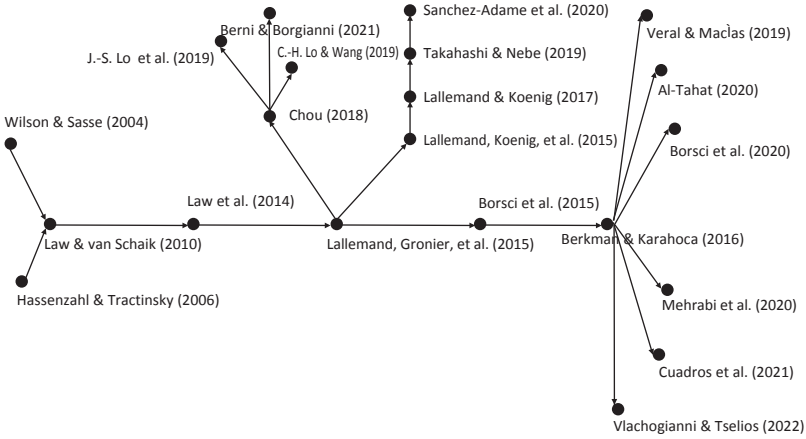
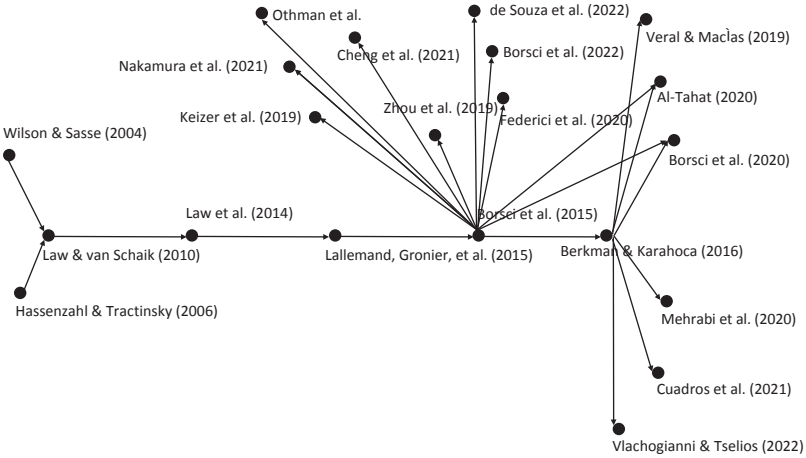

Sanchez-Adame et al. (2020)
Berni & Borgianni (2021)
Veral & Macìas (2019)
J.-S. Lo et al. (2019)
C.-H. Lo & Wang (2019)
Takahashi & Nebe (2019)
Al-Tahat (2020)
Lallemand & Koenig (2017)
Chou (2018)
Wilson & Sasse (2004)
Lallemand, Koenig, et al. (2015)
Borsci et al. (2020)
Law et al. (2014)
Borsci et al. (2015)
Law & van Schaik (2010)
Lallemand, Gronier, et al. (2015)
Berkman & Karahoca (2016)
Hassenzahl & Tractinsky (2006)
Mehrabi et al. (2020)
Cuadros et al. (2021)
Vlachogianni & Tselios (2022)

Figure 3 Multiple Main Path B


Othman et al.
de Souza et al. (2022)
Veral & Macìas (2019)
Cheng et al. (2021)
Borsci et al. (2022)
Nakamura et al. (2021)
Al-Tahat (2020)
Zhou et al. (2019)
Federici et al. (2020)
Keizer et al. (2019)
Wilson & Sasse (2004)
Borsci et al. (2020)
Law et al. (2014)
Borsci et al. (2015)
Law & van Schaik (2010)
Lallemand, Gronier, et al. (2015)
Berkman & Karahoca (2016)
Hassenzahl & Tractinsky (2006)
Mehrabi et al. (2020)
Cuadros et al. (2021)
Vlachogianni & Tselios (2022)

Conclusion

The study shows that UX research has moved from the early concept of usability in HCI to include comprehensive experience metrics such as emotion, aesthetics, context and social interactions. Measurement methods have also been extended from subjective assessment to psychophysiological data and structured questionnaires, reflecting the continuous integration between theory and practice. However, this study also points out the limitations of the MPA method, especially in presenting only the main "road" of the largest flow, which may not be able to represent the non-mainstream but forward-looking research perspectives in the field of UX. The authors suggest that in the future, MPA can be supplemented by subdividing the domains or combining qualitative methods to construct a more complete knowledge map.

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In conclusion, this study has successfully utilized the MPA technique to depict the process of UX research from conceptual vagueness to more structured measurement, and to present the expansion of UX concepts into multiple application domains. The contribution of this study is to provide a systematic review of the literature, which not only clarifies the theoretical progress in the field of UX but also serves as a reference to key literature and development direction for future researchers. In addition, this study demonstrates the practical value of the MPA approach in mapping the evolution of knowledge, especially in dealing with highly diffuse and cross-disciplinary research areas.

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探索使用者經驗研究發展趨勢：學術引文網路的主路徑分析

陳書儀[a]　盧昕毓[b]　黃俊閎[a*]

摘要

隨著科技進步，使用者越來越注重使用經驗和服務體驗。為了更瞭解使用者經驗（user experience，簡稱UX）在學術研究中的發展，本研究希望透過引文分析與主路徑分析（Main Path Analysis，簡稱MPA）方法，由相關文獻資料中找出UX知識發展的主要路徑與脈絡，並提供後續研究者參考。研究結果發現UX研究可以分為三個階段：一、著重UX主觀與客觀概念的發展（2004-2009）；二、建立UX概念的模式、瞭解大眾對模式與量測的看法（2010-2014）；三、改善與深化UX的測量（2015-2021）。研究亦提供對UX與主路徑分析研究的建議。

關鍵詞：使用者經驗，主路徑分析，引文分析

前　言

隨著科技的進步，除了產品的主要功能與使用目的之外，消費者也關注商品帶來的感受和互動性，開啟了使用者經驗（user experience，簡稱UX）領域的發展。使用者經驗發展至今已有卅餘年，相關概念與方法也逐漸深入各種產品與服務的發展過程。無論產業，來自產品使用者的目標、困難與使用行為，都是企業改善產品與研發新方向的藍海。雖然在業界應用廣泛，但一些學者認為使用者經驗的概念沒有共識（Lallemand, Gronier, et al., 2015），也因此阻礙了相關理論的發展。因此如何更掌握學術研究中使用者經驗概念的發展軌跡，就成為一個重要的研究方向。

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此篇文章之同儕評閱意見報告（Open Point）及導讀簡報（InSight Point）請至本刊網站查閱
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早期有學者認為因為使用者經驗缺乏實證研究，才較少看到學術領域中的討論（如Hassenzahl & Tractinsky, 2006）。隨著時間的進展，使用者經驗在學術領域中的發表也逐漸累積。本文以收錄在Web of Science資料庫的研究論文為基礎，並以主路徑分析（main path analysis，簡稱MPA）的方式探索使用者經驗研究的發展和應用，希望回答此一研究問題：使用者經驗研究發展過程中，相關知識如何累積、開展與轉變？期望在眾多研究中能釐清使用者經驗概念的變化與進展。此外，也希望更瞭解主路徑分析的應用優點與限制。

二、文獻回顧

㈠使用者經驗概念的發展

在人機互動領域發展初期，與使用者經驗相關的概念是易用性（usability），主要關注去除負面的使用問題、協助使用者完成任務（Hassenzahl, 2004）。1990年代，Norman認為易用性一詞太過狹隘，是第一批以「使用者經驗」一詞來描述使用系統之各方面體驗的作者之一（Lallemand, Gronier, et al., 2015; Norman et al., 1995）。同時使用者經驗的概念也逐漸與易用性分開：使用者經驗通常指涉較完整、全面的使用體驗，例如在討論互動系統的使用上，ISO 9241-210的定義就希望涵蓋更廣泛的體驗層面：「一個人因使用或預期使用產品、系統或服務而產生的知覺和反應。包括使用者所有感情、信念、偏好、知覺、生理與心理反應、行為，和成果」（International Organization for Standardization [ISO], 2010）。而易用性逐漸成為使用者經驗的一個子概念，通常用在系統或介面是否能有效的達成使用者的目標、讓使用者滿意，如ISO的定義所示：「產品（或服務）能達到目標的效能、效率和滿意度的程度」（ISO, 2010）。

然而如同「經驗」的概念相當複雜，延伸到「使用者經驗」一詞亦復如此，除易用性外還涵蓋了許多不同意義，學者與理論間常無一致的共識（Forlizzi & Battarbee, 2004）。舉例來說，一些學者強調使用者經驗不僅與工作環境、任務相關，亦即不應只考慮互動產品的工具性層面，也應包括美感、享受、整體品質（goodness）等正面體驗與感受（如Hassenzahl & Tractinsky, 2006）。許峻誠（2019）也認為使用者經驗的因素包含使用性（即易用性）、美感與情緒。然而同樣也有部分學者對於美感、情緒是否適合衡量有不同看法（Law & van Schaik, 2010），使得使用者經驗這個概念有時落入眾說紛紜、莫衷一是的情況。

可能因為缺乏共識，學術上較常見的仍是與易用性相關的量化研究。研究人員透過測量使用者的情緒和感受，希望將質性的結果以數值表達並建立量表（如Lallemand, Gronier, et al., 2015; Law et al., 2014等），甚至有學者認為測試生理反應的表徵更能夠傳達使用者的狀態（如Wilson & Sasse, 2004）。無論透過何種方式，這些學者相信以量化方式衡量使用者經驗是必要、合理和可行的途徑

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（Lallemand, Gronier, et al., 2015）。特別在實務的應用中，非常需要快速評估與瞭解系統的易用性，這也導致研究中有許多關於易用性量表的發展與建立。然而除了量化取向的易用性研究之外，使用者經驗研究在多年累積之下仍有不同的發展途徑與方向，也正是本研究希望瞭解的議題。

㈡主路徑分析

主路徑分析是一種文獻分析的方法，可以找出文獻之間相互引用關係建構而成的引文網路中，最主要的引用關係與發展路徑（Hummon & Doreian, 1989）。引文和被引用文獻會形成引文網路，由節點（vertex）與有向線段（arc）組合而成；其中節點代表一篇文獻，有向線段則代表引用關係。由於文獻具有引用與被引用兩種關係，因此連接關係的線也具有方向性，其方向是從被引用端指向引用端（Batagelj, 2003; Liang et al., 2016）。在引文網路中，源點（source）是被引用的節點，但沒有引用其他節點，也就是引文網路的起始點；匯點（sink）是引用其他節點但未被引用的節點，也就是引文網路的結束點（Liu et al., 2013）。換句話說，源點所引用的文獻，並未出現在此引文網路中，否則該節點就不會是源點了；而引用匯點的文獻，同樣不在引文網路中。

主路徑分析的目的是追踪引文網路中的主要知識流（Liang et al., 2016），改善了過去引文分析的一些限制。以往分析引文網路主要使用書目耦合（bibliometrics coupling）和共被引分析（co-citation analysis）這兩種方式。兩者均注重引用（或共同引用）次數（Liang et al., 2016），依據引用概念發展相似性，能將類似主題的研究聚集與分群來檢視其共同與差異；但這兩種方法較難顯示整個引文網路中知識的發展、累計與轉變（Hummon & Doreian, 1989）。

Hummon與Doreian（1989）所提出的主路徑計算方法，是以計算資訊流量（traversal counts，或稱經過次數）的方式來找出引文網絡中的主要路徑，將資訊流量較高的線段連結起來形成一條主要知識發展路徑。資訊流量的概念希望呈現每個線段的重要性。舉例來說，在一個引文網路中，若列出由所有源點連結至所有匯點的全部可能路徑，那麼某一個線段出現的次數愈高（即該線段出現在較多的可能路徑中），則該線段在這個引文網路中的重要性愈高。

Hummon與Doreian（1989）提出了多種計算資訊流量的方式，包括Node Pair Projection Count（簡稱NPPC）、Search Path Link Count（簡稱SPLC）和Search Path Node Pair（簡稱SPNP）等。之後Batagelj（2003）引入Search Path Count（簡稱SPC）來輔助SPLC和SPNP的計算，並認為NPPC不適合用在較大的引文網路（如10,000個節點以上）。SPC的計算即如前例所述，找出引文網路中由每個源點連結到每個匯點的所有路徑，並計算每個線段出現在所有路徑上的次數，即為該線段的資訊流量總次數（Liang et al., 2016）。一般認為SPC比原來SPLC及SPNP更適合用於數千節點的大型網路分析（Batagelj, 2003），也有應用於引文網路主路徑分析的例子（如Liang et al., 2016）。

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資訊流量計算完成後，可以開始建立主路徑。一般有三種尋找主路徑的方式（Hummon & Doreian, 1989; Liu & Lu, 2012），分別是逐步主路徑（local main path）、總體主路徑（global main path）和關鍵延伸主路徑（Key-route）。逐步主路徑由源點開始，選擇所有與其連結線段中資訊流量最大者，再依序選擇下一段資訊流量最大連結，一直到匯點為止，亦即運用貪婪演算法的概念逐步前進。總體主路徑則計算由每一個源點至每一個匯點所有可能路徑的路徑資訊流量總和，並選擇其中資訊流量總和最大的一條路徑。相較逐步主路徑，總體主路徑較能顧及整體引文網路中知識流的進行，而不易受到小範圍高資訊流量（引用關係）的影響。關鍵延伸主路徑則希望不要遺漏整個網路中資訊流量最高的關鍵線段，因此選擇資訊流量最高的一或多個線段為起點，往上下游延伸尋找主路徑；同樣可採用逐步或總體的主路徑選擇方式（Liu & Lu, 2012）。本研究選擇總體主路徑，因其能展現整體引文網路中重要的知識分布，強調了知識流的整體重要性（Liu et al., 2013）。此外，由於主路徑只有一條，也有學者建議採取多重（multiple）主路徑，也就是選擇流量次高（或第三、第四高等等）的主路徑，能更完整呈現知識發展的全貌，但需留意數量勿過度複雜，反而失去主路徑表達重要發展途徑的初衷（Liang et al., 2016）。本研究考慮主路徑的複雜性和簡潔間的平衡，亦加入多重總體主路徑，並考慮適當的關鍵延伸主路徑一同分析。

三、研究方法

㈠研究流程

本研究針對研究主題進行相關文獻搜集，於Web of Science中檢索使用者經驗相關的關鍵字。之後匯出文獻的完整記錄和引用的參考文獻，並將資料以HistCite與Pajek找出主路徑上的論文，以建立與繪製主路徑。由於與使用者經驗相關的概念很多，研究者也經常使用不同的關鍵字，使得研究結果較為分散、也造成搜尋的困難。因此本研究先根據論文篇目內容嘗試並調整關鍵字，經過數次分析，確定與研究主題相關的關鍵字。在主路徑產生之後，閱讀和整理主路徑涵蓋的文獻，分析文獻間關聯與討論，進而提出結論與建議。研究流程大致如下：1. 確立研究主題與範圍；2. 檢索與縮限關鍵字；3. 蒐集資料與主路徑建立；4. 分析結果與討論；5. 提出結論與建議。

㈡資料來源和檢索方法

1. 資料來源

Web of Science是一個引用文獻索引系統，收錄多個具影響力的期刊和會議論文資料庫。本文資料源自1996年後收錄在Web of Science資料庫的論文，檢索期間至2021年10月為止。

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2. 檢索方法

以使用者經驗領域常用詞彙作為關鍵字（包括“user experiences”、“experience design”、“usability”、“user-centered design”），針對所有欄位進行搜尋作為起始搜尋條件設定。初步的結果高達數十萬筆，但檢索過程中發現關鍵字出現在標題和作者關鍵字欄位的論文內容與本研究主題相關性較高，因此將檢索條件縮限在「標題」與「作者關鍵字」，共有16,888筆。若僅以“user experience”為關鍵字，則僅有2,382筆。

㈢資料分析工具與步驟

本研究使用引文分析軟體Histcite和社會網路分析軟體Pajek，來進行資料分析、資料轉換和繪製主路徑圖。具體步驟包括：1.將搜尋結果的引文網路資料以「完整資料和引用文獻」的純文字檔匯出。2.使用HistCite繪製所有資料的引文關係並匯出成Pajek可讀取的檔案類型。3.使用Pajek產生並繪製引文網路圖。

Pajek可以使用三種資訊流量的計算（SPC、SPLC和SPNP），本研究以SPC為資訊流量計算的方式。值得注意的是選擇資訊流量繪製主路徑之前，要先確定當前的引文網路是非循環（acyclic）網路，因為有循環連接的情況下無法尋找總體主路徑。此外，也必須先處理和其他文獻較少連結的弱連結，亦即排除不在主要「集團」中的文獻。使用Pajek的資料處理過程包括：1.匯入資料，得到所有篇數個數的節點。2.移除弱連結。3.收斂強連結。4.移除迴圈。篩選後的文獻節點及其間引用關係，形成本研究分析基礎的引文網路，並以此計算資訊流量與建立主路徑。後續內容中本研究將提出所建立的主路徑及路徑中的文獻，並據此說明與觀察分析使用者經驗研究的發展。

研究過程中首先以前述16,888筆進行分析，獲得18篇主路徑論文。進一步檢視發現大部分均集中在易用性概念與量測的探討；18篇中有16篇的標題含有“usability”一詞。其中亦有多篇僅在討論易用性的概念與測試方法（如Følstad & Hornbæk, 2010; McDonald et al., 2012; Tractinsky, 2018）。雖然易用性是使用者經驗中的重要概念（Law & van Schaik, 2010），但由於易用性的發表與引用較多，引用數量將導致主路徑的結果偏向以易用性相關研究為主。由於本研究希望探討更廣泛的使用者經驗相關研究，而非僅限於易用性此一子概念，因此決定排除“usability”一詞，僅以“user experience”為關鍵字，同樣將檢索條件縮限在「標題」與「作者關鍵字」，獲得2,382筆，後續所產生的主路徑有13篇。相較之前未排除易用性的主路徑（18篇），路徑中僅有兩篇論文相同，顯示此次結果受到易用性影響較小，但結果仍然涵蓋易用性此一重要概念。

2,382篇處理過程如前述：1.匯入資料，得到2,382個節點。2.移除弱連結，得到825個節點。3.收斂強連結，得到824個節點。4.移除迴圈，留下824個節點。篩選後的824個文獻節點及其間引用關係，形成本研究分析基礎的引文

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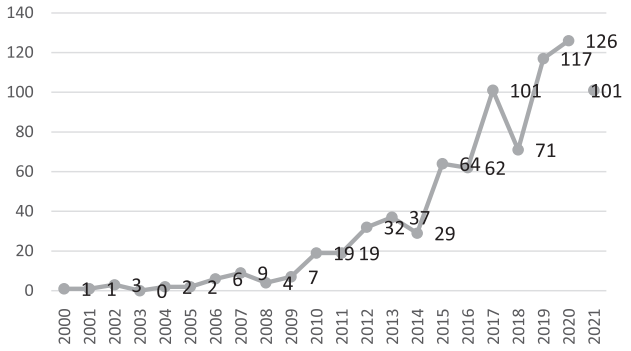
網路，並以此計算資訊流量與建立主路徑。後續內容中本研究將提出所建立的主路徑及路徑中的文獻，並據此說明與觀察分析使用者經驗研究的發展。

四、結果與討論

㈠引文網路

本研究經過資料處理、移除弱連結與循環後留下824個節點（代表824篇論文），基於這些節點形成的引文網路代表相關研究中彼此互相引用所形成的主要部分（集團）。這些論文收錄在311個期刊和一本書刊中，其中發表數以2020年最多（126篇），其次為2019年（117篇）；年代分布請見圖1。期刊則主要集中在人機互動為主題的期刊，包括International Journal of Human-Computer Studies（47篇）、Behaviour & Information Technology（31篇）、Interacting with Computers（31篇）、International Journal of Human–Computer Interaction（30篇），和Computers in Human Behavior（29篇）等。數量前五名期刊即佔所有824篇之五分之一，其他發表數量較多之期刊請見表1。

圖1　用於分析之引文網路（824篇）年代分布



註：僅繪製813篇，扣除早期取閱與2022年文獻；2021年由於資料僅至10月，因此以單獨的點標示出。

表1　論文期刊收錄統計（前11位）

期　　刊	篇數	發表年分
International Journal of Human-Computer Studies	47	2001-2021
Behaviour & Information Technology	31	2006-2020
Interacting with Computers	31	2004-2019
International Journal of Human–Computer Interaction	30	2002-2021
Computers in Human Behavior	29	2012-2021
Journal of User Experience	18	2015-2020
IEEE Access	15	2018-2021
Multimedia Tools and Applications	15	2014-2021
Personal and Ubiquitous Computing	13	2005-2021
Sensors	13	2018-2021
Universal Access in the Information Society	13	2011-2021

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㈡主路徑分析結果

依據前述調整關鍵字、搜尋相關文獻，以及整理收斂引文網路，並計算資訊流量、建立總體主路徑後，獲得由13篇論文構成的總體主路徑，如圖2所示；詳細的引用關係見表2。

這個主路徑上共有13個節點，發表時間由2004到2021年的17年間。時間的分布是2004、2006、2010、2014、2016和2019年各一篇，2015和2021年各兩篇，以及2020年的三篇論文。以作者來說，兩位作者（Effie L.-C. Law和Simone Borsci）各有兩篇論文在這條路徑上。

圖2　總體主路徑（Global Main Path-SPC）

Veral & Macàs (2019)
Al-Tahat (2020)
Borsci et al. (2020)
Wilson & Sasse (2004)
Law et al. (2014)
Borsci et al. (2015)
Law & van Schaik (2010)
Lallemand, Gronier, et al. (2015)
Berkman & Karahoca (2016)
Hassenzahl & Tractinsky (2006)
Mehrabi et al. (2020)
Cuadros et al. (2021)
Vlachogianni & Tselios (2022)

表2　論文引用關係整理

路徑上文獻	引　用
Wilson與Sasse（2004）	源點
Hassenzahl與Tractinsky（2006）	源點
Law與van Schaik（2010）	Wilson與Sasse（2004）、Hassenzahl與Tractinsky（2006）
Law等（2014）	Law & van Schaik（2010）
Lallemand、Gronier等（2015）	Hassenzahl與Tractinsky（2006）、Law與van Schaik（2010）、Law等（2014）
Borsci等（2015）	Hassenzahl與Tractinsky（2006）、Lallemand、Gronier等（2015）
Berkman與Karahoca（2016）	Borsci等（2015）
Veral與Macàs（2019）	Hassenzahl與Tractinsky（2006）、Berkman與Karahoca（2016）
Al-Tahat（2020）	Borsci等（2015）、Berkman與Karahoca（2016）
Borsci等（2020）	Borsci等（2015）、Berkman與Karahoca（2016）
Mehrabi等（2020）	Berkman與Karahoca（2016）
Cuadros等（2021）	Berkman與Karahoca（2016）
Vlachogianni與Tselios（2022）	Berkman與Karahoca（2016）

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主路徑上的文獻大多來自人機互動（Human Computer Interaction，簡稱HCI）相關期刊（包括International Journal of Human-Computer Interaction的三篇，Interacting with Computers的兩篇，以及International Journal of Human-Computer Studies、Computers in Human Behavior、Behaviour & Information Technology、Applied Ergonomics等）。由於使用者經驗在學術界中主要由HCI開始發展（Hassenzahl & Tractinsky, 2006），因此集中在與電腦使用者行為相關的期刊並不意外。

這一條總體主路徑是以Wilson與Sasse（2004）和Hassenzahl與Tractinsky（2006）為源點開始，集中到Law與van Schaik（2010）之後構成一條主要路徑，最後在Berkman與Karahoca（2016）之後發散至五個匯點，論文引用關係如表2所示。由於「使用者經驗」一詞大約始於1995年（Norman et al., 1995），但如前述，至少將近10年之後，學界對這個概念的看法仍相當不一致（Forlizzi & Battarbee, 2004）。因此路徑中的源點由2004與2006開始，十分符合實際發展狀況。

此外，由表2的引用關係可以發現兩個源點中，Hassenzahl與Tractinsky（2006）對後續研究的影響力較Wilson與Sasse（2004）強勢，受到路徑中其他三篇的引用（除了路徑上直接的下一篇引用文獻之外）。由於Hassenzahl與Tractinsky（2006）提出當時對未來UX研究發展的看法，因此相當合理。再者，引用關係中同樣可觀察到Borsci等（2015）亦受到路徑中另外兩篇的引用（除了路徑上直接的下一篇引用文獻之外），同樣表示Borsci等（2015）由使用者經驗的角度來評估幾個相關滿意度量表，受到較多的注意。兩者都顯示研究調整選擇後的關鍵字，的確較能找出以使用者經驗為中心的研究。

由於較近期的文獻在引用數量上較低，因此也可能出現如本研究中在主路徑最後發散的現象；因為尚未有足夠的後續研究累積，因此資訊流量可能不會有太大差異。

從這個主路徑結果可以觀察到一部分使用者經驗研究的發展。早期研究人員以人機互動為開端，雖然一開始多數與易用性相關，但在使用者經驗概念出現後，一些研究者逐漸將這個概念與現有易用性研究連結，也希望加入更多主觀和美感的感受層面（Hassenzahl, 2004）。然而在本研究發現的主路徑中，多數仍的確與使用者經驗的量測（不一定是易用性的量測）相關。經由閱讀總體主路徑上的論文後，本研究試將路徑呈現的使用者經驗研究發展分為三個歷程。

1. 2004年至2009年：使用者經驗的主觀與客觀角度

從1980年代中期開始，研究者注意到使用者成本的概念，希望將其與使用績效與滿意度連結，也嘗試用許多方式來衡量和評估。Wilson與Sasse（2004）則希望更客觀地衡量使用者的狀態，以帶來對使用者經驗更直接的連結。他們

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應用心理生理學方法，透過自律神經測量皮膚電導、心率和血容量脈搏，結合傳統HCI的評估方法，即任務績效和使用者滿意度，來驗證媒體品質下降對使用者的影響。結果顯示心理生理學數據能反映影音品質下降，但心理生理反應並不總是相互關聯，同時主觀和生理測量並不一定一致。這代表心理生理數據可能會檢測到使用者在實驗後主觀評估中不知道或無法回憶的反應。因此，Wilson與Sasse（2004）認為心理生理學測量在媒體品質評估中有重要作用，也應該為使用者經驗研究者採納。雖然這個研究以後續的路徑來看並非十分核心（生理心理量測），但顯示當時使用者經驗的測量已經到了瓶頸，需要往更多方向來捕捉使用者的反應，強化體驗測量的全面性，也希望以更客觀的資料來輔助主觀評估的結果。

在另一方面，2000年初期隨著技術的成熟，互動式產品變得不再只注重有用和易用，同時也能非常流行與吸引人。這也使得體驗與感受中除了績效的其他層面，如情感、享樂、美觀等角度開始受到重視。為了增進關於使用者經驗更全面的瞭解，Hassenzahl與Tractinsky（2006）藉由彙整使用者經驗的實證研究，提出未來UX的研究方向建議，認為UX應該不僅考慮用途，也應思考美觀與樂趣；UX應該納入對感情與情緒的主客觀衡量；此外亦應考慮體驗的動態、獨特、脈絡性。唯有這三者都獲得適當重視與研究，使用者經驗的概念才能更清晰。因此Hassenzahl與Tractinsky（2006）認為UX是使用者內部狀態、設計系統的特徵和互動發生與相關脈絡影響的結果。使用者經驗將專注於如何創造高品質的體驗，而不僅僅是防止易用性問題。

在這個階段（2004至2009年）中，可以看到兩個方向的發展，也就是體驗的主客觀概念與衡量，分別受到大家的重視。早期人機互動的研究幾乎完全集中在工作環境中的行為和目標的實現上，而在沒有對UX一詞統一定義的情況下，部分研究者仍希望對經驗的客觀衡量更為有效，但也開始有學者留意「經驗」中更複雜的主觀、詮釋層面。

2. 2010年至2014年：使用者經驗的模式與量測的接受程度

延續前述主客觀的不同角度，Law與van Schaik（2010）希望進一步結合UX主客觀中的概念，提出能衡量與評估的UX模式。他們提出的概念模式中，涵蓋體驗中實用（使用者感知易用性）與享樂（產品帶來的樂趣）兩種性質，也加入美學與優良（goodness，整體的品質）等構念。和Hassenzahl與Tractinsky（2006）類似，Law與van Schaik（2010）也是同一期期刊中多篇相關文獻的介紹文章，承續Hassenzahl與Tractinsky（2006）的呼籲，邀集多篇相關研究，並提出對UX模式未來建立的方向。Law與van Schaik（2010）強調測量的信度和效度，說明效度應該建立在經驗、意識、記憶、感受、情緒、美學、社會協作和互動等相關理論框架的理解。信度則取決於使用資料收集工具和規則的一致性。

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在當時來說，使用者經驗作為一個新興研究領域，仍受到一些挑戰，特別是如何衡量的操作性定義。Law等（2014）接續先前的研究主題，探討使用者經驗領域中對結構化測量標準的看法。研究邀請10位學界和一位業界專業人員進行半結構化訪談。結果顯示設計導向的專業人員對使用者經驗測量保持懷疑的態度。因此，Law等（2014）以相同問題在HCI社群中進行了調查（UX Measurement Attitudes Survey）以進一步驗證。調查結果顯示，人機互動領域中對使用者經驗測量的態度較前述訪談結果正面，且會對測量提出修改建議。

後續在2014年時，Lallemand、Gronier等（2015）重複Law等（2009）進行的使用者經驗調查，並擴大範圍至更多國家與地區，希望瞭解從業人員對UX的看法，並分析隨著時間的推進、理論和實務之間概念上的轉變。研究發現大部分結果支持先前的研究，例如使用者相關因素和脈絡因素同樣重要，當下的體驗較事後評估較受重視等。與Law等（2009）不同的是這次的受訪者認為UX並非新觀念，過去的使用者中心設計與易用性角度已能大幅涵蓋UX觀念。至於應以量化或質化方式研究UX，調查並沒有清楚的答案。

由這個階段（2010至2014年）的三個研究可以看出，研究者嘗試匯整前一階段中UX的主客觀性質，並希望能加以衡量，納入可研究的範圍中。相關領域從業者對衡量與模式的看法雖然與學界、設計導向的專業人員不盡相同，顯示實務界對「可衡量」這種想法有更高的需求。而Lallemand、Gronier等（2015）的調查也發現專業人員對UX的概念在某些方向漸趨一致，雖然在一些層面仍有分歧。藉由這些觀點，後續對使用者經驗測量和模型的建立與改善得以更有基礎。

3. 2015年至2021年：使用者經驗測量的改善與深化

延續前一階段，由於實務界需要衡量UX，愈來愈多的測量量表與模式開始發展。其中1996年提出、原本發展給一般資訊系統使用的系統易用性量表（System Usability Scale，簡稱SUS）是少數廣泛應用、也具有客觀參考分數的易用性測量工具之一（Bangor et al., 2008）。雖然奠基於易用性，但SUS經常用來衡量UX。此外，在2010年與2013年發展出來的Usability Metric for User Experience（以下簡稱UMUX）和UMUX-LITE，也受到許多關注與應用。然而當時沒有研究進行太多量表的信度分析，也沒有根據與產品的不同互動變量來分析量表的信度。Borsci等（2015）希望能分析不同網站使用經驗的使用者同時完成SUS、UMUX和UMUX-LITE之間的差異，並以大學生為對象進行研究，結果發現所有量表都具有很強的相關性，可以用作評估使用者滿意度的快速工具。

Berkman與Karahoca（2016）延續UMUX和UMUX-LITE（以及其他量表，包括SUS）的比較，以心理測量方法重新評估這兩種量表，為信度、效度和敏感性提供了更多研究結果。研究結果支持UMUX及UMUX-LITE是與SUS顯著相關的信度量表，也具有一定程度的敏感性，可區分不同的系統。

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這個階段的其他研究由於較為近期，因此尚未有太多的引用數據，也較難顯示出明確的未來發展。但這些研究大都延續測量的主題（多數使用UMUX或UMUX-LITE），因此是未來發展的合理方向。以下簡單描述這些研究的內容。

Veral與Maclàs（2019）將質性評估轉化為有助於建立基準的量化指標，用於比較評估感知易用性，使用Reaction Cards的方式瞭解使用者的想法。這種方式可以快速的得到使用者主觀的情感資訊，Veral與Maclàs（2019）使用專家驗證和開發研究工具usAbility aSsessment SUpported by ReActioN-Cards Evaluations（簡稱ASSURANCE）來解決主觀的問題。研究結果系統化感知使用性的評估，並對不同系統或軟體進行比較評估設計。

Al-Tahat（2020）翻譯UMUX和UMUX-LITE為阿拉伯文，為相關語系使用者和從業人員提供更好的問卷。由於目前的問卷最初是為英語使用者開發，一些概念與詞彙對非英語人士可能難以理解，誤解題意在填答時可能使結果產生偏差。為了確保阿拉伯文版本的UMUX可以應用於阿拉伯文化，Al-Tahat（2020）進行語言和文化適應性研究，驗證其內容有效性、表面效度和信度。問卷翻譯的驗證結果顯示翻譯後的量表與原始英語UMUX和UMUX-LITE相同。

Borsci等（2020）希望瞭解是否能使用UMUX-LITE來快速評估新興醫療科技的使用體驗，以及與Net Promote Score（以下簡稱NPS）指標的關係。他們針對120名醫療保健專業人員評估了六種處於不同開發階段的定點照護（point-of-care）產品。研究結果顯示UMUX-LITE可以單獨使用，也可以與NPS結合使用，以調查新產品在不同階段的體驗品質。

Mehrabi等（2020）以聲音傳輸資料的技術（Chirp）為基礎的服務，並希望大幅減少接觸、工作量和互動時間，以最少或不需要使用者干預的方式傳輸，以改善使用者經驗。實驗結果顯示Chirp的實際交易時間最短，其次是QR code，最後是藍芽。這個研究事實上是一個技術研究，只是因為使用並引用了UMUX的相關研究，加上引用數字與其他研究相同，因此納入了這次的主路徑。

Cuadros等（2021）希望建立評估遠端實驗和遠端研究室的統一標準，因此結合教育和應用程式相關問卷，設計出User eXperience Questionnaire（簡稱UXQ）。對兩個不同的遠端實驗室進行問卷調查，在不同的校園和不同課程中收集了180份資料以評估問卷。最後經過評估與驗證後修正問卷版本包含易用性、實用性和沉浸感的量表（UXQ4RL v. 1.0）。

Vlachogianni與Tselios（2022）研究人格特質對線上學習平台感知易用性的影響，考慮線上學習平台的使用和易用性、人口統計因素和感知易用性的關係，以及和個性對線上學習平台的易用性評估。他們以SUS和五大人格測試，及人口統計問卷，針對九個線上學習平台，對2,239名希臘中小學教師通過線上測驗。結果顯示Google Classroom、Microsoft Teams、Edmodo、Skype和Zoom具有令人滿意的易用性水準。此外SUS分數與受測者的年齡、性別、教育階

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段、教師的教育水準、工作經驗、公私立學校、工作關係、學區、資通訊科技能力無關。就人格特質而言，對新體驗的開放性和外向性與感知可用性評估具有最強的正相關等。

這個階段（2015至2021年）接續之前的階段，開始出現成熟的UX量測量表，基於這些量表的研究，以及新建立的量表。如前所述，由於時間較近，這些研究有些不完全與使用者經驗相關，有些則偏向較易受到引用的量表相關主題。雖然如此，但放在整體UX的研究範圍中，仍然可以發現這個階段反映與延續前面的階段，研究者深入量測的概念，對現有常用量表給予更嚴苛的評測，並建立新的測量量表與角度。

整體而言，使用者經驗領域在整合主觀、客觀不同性質與研究角度後，特別在實務界較多擁抱量測的概念。因此研究的方向漸漸轉向模式的建立，特別是量表的發展與應用。雖然一些量表中同時涵蓋主客觀測量的變項，但由UX研究發展的過程中仍然可以發現部分概念較受到忽略（因而無法在主路徑中觀察到），包括使用體驗的獨特性，以及社會性脈絡對體驗的影響。這部分或許應該在未來的研究中更多發展。

4. 討論

郭凱慶（2024）的研究亦以使用者經驗為主題，蒐集2003至2023年的1,625篇Web of Science相關文獻（但搜尋僅限標題）。與本研究不同之處除搜尋條件與資料時間點差異之外，方法則使用VOSviewer、SiteSpace對所有文獻進行分析。在共現詞彙的分析中，發現關鍵字的五個主要分類：相關技術發展（如虛擬實境、機器學習等技術）、體驗方法應用（即衡量體驗與服務品質的不同量化模型）、滿意度與忠誠度、易用性、行為與情感。此外，郭凱慶（2024）亦將使用者經驗的發展分為早期（2003-2010）、發展期（2010-2018）與成熟期（2018-2023），分別對應易用性測試與使用者研究的早期嘗試，開始注重量化的衡量，以即更全面的應用。由於郭凱慶（2024）是彙整1,625篇的整合結果，相較本研究會更完整，但也會更廣泛。而本研究的分期也可約略對應至郭凱慶（2024）中較細節的部分。

雖然分析的基本引文網路不同，但仍可據此觀察本研究使用主路徑分析方法可以獲得相近的成果，顯示此一方法的價值與功用。

㈢多重主路徑

為了更多探索UX概念的發展，本研究亦嘗試以多重主路徑來觀察發展路徑的變化。多重路徑的路徑數量選擇沒有明確規定，有學者建議將設定在最大SPC值的前百分之20或是引文網路前五分之一的路徑（Liang et al., 2016; Li et al., 2011），但仍依分析的需求而定。由於本研究希望專注於最核心概念的發展，因此依照多重主路徑的複雜性，將多重主路徑取值在最大SPC值的前百分之

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10。最終形成由29篇論文所構成的多重主路徑，其中包含前面討論的總體主路徑13篇，以及由Lallemand、Gronier等（2015）延伸出的路徑八篇（圖3之多重主路徑A），和由Borsci等（2015）延伸出的路徑10篇（圖4之多重主路徑B），其中Borsci等（2015）路徑有兩篇與原總體主路徑尾節點的篇目重複。為了清楚說明，圖3呈現多重主路徑中由Lallemand、Gronier等（2015）延伸出的路徑A（以紅色線條表達）及原總體主路徑，圖4呈現由Borsci等（2015）延伸出的路徑B（以紅色線條表達）及原總體主路徑。

由Lallemand、Gronier等（2015）延伸出之多重主路徑A的研究中，往Chou（2018）延伸的四篇文獻主題圍繞在使用者經驗在系統互動的表現，這些研究結果對使用者經驗的定義和量表有推進的意義。Chou（2018）以使用者經驗指標為技術設計出心理測量模型，用以測量互動式產品（如滑鼠）的使用者經驗品質

圖3　多重主路徑A（Multiple Main Path A）

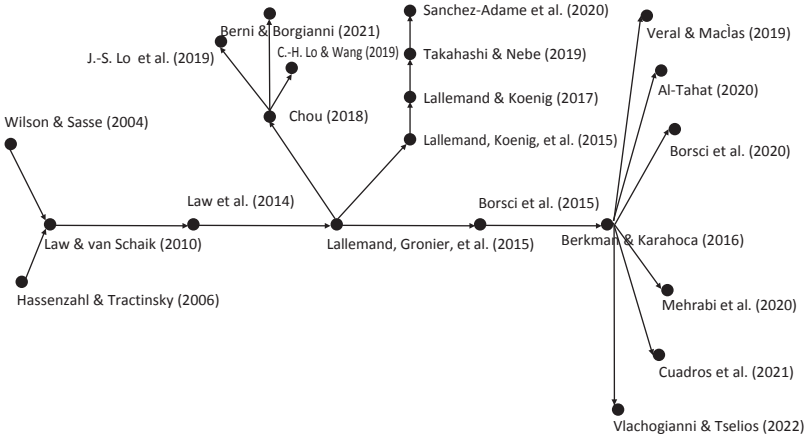
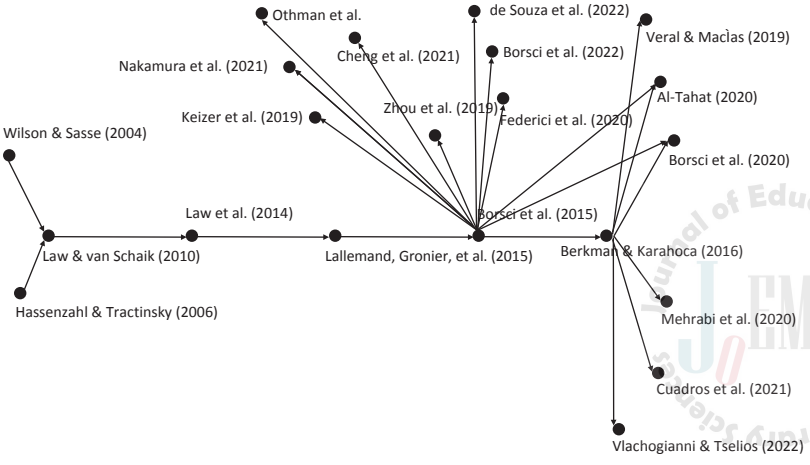


圖4　多重主路徑B（Multiple Main Path B）



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指標。其他包含課程輔助系統（J.-S. Lo et al., 2019）、無人商店（C.-H. Lo & Wang, 2019）和語意網（Berni & Borgianni, 2021），這些研究都對使用者經驗的定義和量表有更進一步的解釋。在另一方面，多重主路徑A往Lallemand、Koenig等（2015）延伸的四篇文獻脈絡較有順序性，共同點是對AttrakDiff量表做研究，其中分別是提升量表內容和使用的全面性（Lallemand & Koenig, 2017; Lallemand, Koenig, et al., 2015）與量表的應用（Sanchez-Adame et al., 2020; Takahashi & Nebe, 2019）。

由Lallemand、Gronier等（2015）延伸出之多重主路徑A的研究多專注在使用者經驗的測量工具和定義上，由於論文發表時間與研究時間較接近，受到引用的影響在Borsci 等（2015）路徑上未能找到較收斂的路徑結果，相反地，Borsci等（2015）的路徑B較能反應現今的科技背景和研究選題上的多元發展。

五、結論與建議

㈠研究發現

本研究資料採1996年至2021年10月間收錄在Web of Science資料庫的文獻，以“user experience”作為關鍵字搜尋。從主路徑分析結果觀察使用者經驗的發展，得知早期使用者經驗研究多出現在人機互動領域，以工作環境、效率與績效為主。但也開始有學者注意體驗這一概念的複雜性，希望加入更多主觀、脈絡性的因素。隨著量表的建立和信度的驗證，使用者經驗的模式與測量也更為普及，逐漸出現共通的標準與量表。這也使得使用者經驗的研究領域也開始豐富，且逐漸在各個領域普及，讓不同領域可以更容易地評估商品、服務環境、服務中的好與壞。量表結果以數字化的方式呈現，給服務提供者一個清楚的數據來檢視自己的服務品質。

本研究根據分析結果，進一步將路徑呈現的使用者經驗發展歷程區分為2004-2009、2010-2014和2015-2021三個時期，分別是著重UX主觀與客觀概念的發展（2004-2009），建立UX概念的模式、瞭解大眾對模式與量測的看法（2010-2014），以及改善與深化UX的測量（2015-2021）。

主路徑分析可以快速地呈現一個觀念整體的發展，藉由觀察和分析能看到理論發展的過程，讓讀者可以系統性地認識一個陌生的知識領域。主路徑的目的在顯示整體研究與知識的發展與累積，由於知識發展會受到外在環境（如科技、經濟）的影響，而本研究中總體主路徑上的匯點亦復如此，脈絡的變化會影響節點（單篇研究）的主題與往後研究間的關聯性。由多重主路徑的分支中觀察也可以發現，遠距與科技應用亦可能逐漸改變UX研究的走向。另外，雖然理論方向的論文被引用的較多（特別是UX概念的討論），但關於測量實務也走向更多元的方式進行，模擬真實場景以測量並瞭解參與者的想法與反應；例如虛擬實境、擴增實境和混合實境等都能幫助獲得更完善對使用者的瞭解。

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㈡研究限制

本研究以使用者經驗為核心，然而使用者經驗是一個多元而不易定義的領域。總體主路徑雖可快速觀察一個領域的整體，但細節的發展與變化可能還需加入其他研究方法一同分析，方能完整呈現。以UX領域來說，或許需要將內容做更細節的劃分，依照各自的主題分別建立主路徑，再互相參照，或能對使用者經驗領域的全面性有更完整的掌握。

再者，雖然主路徑分析能將眾多文獻化約為一條（或數條）主要路徑，協助快速掌握領域的發展與變化。但僅關心少數路徑，亦會忽略知識發展中的多樣性（Liu et al., 2019）。

此外，本研究採用Web of Science為引文資料庫的來源，雖然該資料庫已屬收錄甚廣，受到眾多學術機構廣泛支持，然仍可能無法全面涵蓋全部相關文獻，可能造成分析發展趨勢時有所偏誤。

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